MACHINERY.

September, 1904.

A REVIEW OF STEAM TURBINE PATENTS.—1.

Up to 1904 there were over 300 steam turbine patents taken out in the United States and over 400 in England. These patents, in connection with the many that have been issued by the governments of France, Germany, Belgium and other countries, show that a great many inventors have directed their attention to the development of the steam turbine, and we also know that their efforts began at a very early date.

In fact, it is said that the first steam engine was a turbine. In Hero's "Spiritalia," a book on pneumatics issued in the second or third century, is a description of the whirling eolipile consisting of a small hollow sphere mounted on trunnions, one of which is hollow for the admission of steam. The sphere is caused to rotate by the reaction of steam flowing from two diametrically opposite nozzles having bent mouth pieces. This is frequently spoken of as the beginning of the reaction turbine; and to Branca, who issued a work, entitled "The Machine," published at Rome in 1629, is given credit for the first impulse wheel. This volume contains an illustration of an eolipile, in the form of a negro's head, placed over a fire. A blast of steam proceeds from the mouth and impinges against the blades of a large wheel which it was proposed to connect by means of cog wheels with a crude stamping mill for pulverizing drugs. These very early efforts could have been nothing more than visionary schemes, but they are scarcely less impracticable than many of the later inventions to be found in the pages of the patent records. Comparatively few of the steam turbine inventions embody even the first elements of success, probably because most of those who have directed their attention to the subject have failed to understand either what was required or what means must be taken to accomplish good results.

When steam flows through a nozzle from a high to a low pressure, it issues with a velocity so enormous that it is difficult to comprehend its magnitude. The new Springfield rifle adopted by the United States Army gives an initial velocity to its bullet of 2,300 feet per second, or over 26 miles a minute. This is almost exactly the velocity with which steam of 50 pounds gage pressure would issue from a nozzle of the best shape when discharging into the atmosphere. With pressures of 100 or more pounds the velocity of the steam would be between 3,000 and 4,000 feet per second or at a speed of 35 or 40 miles per minute. The problem of converting this velocity into the rotary motion of a turbine wheel is not an easy one to solve, since the wheel must not only run with reasonable quietness and without danger of bursting, or of heating its bearings, but its speed must also be moderate enough to enable the power of the machine to be utilized in doing useful work.

In the successful turbine three main objects must be attained: 1st, as much of the potential energy of the steam as possible should be converted into kinetic energy, or the energy of motion; 2d, the wheel should be capable of utilizing the energy of the steam in an efficient manner; and 3d, the apparatus must run at a moderate speed at the point where it delivers its power.

To accomplish these results the best attainable workmanship and material are required, and this is one reason why the steam turbine has not proved successful until recent years. It is only recently that the quality of materials and workmanship have been such as to make the turbine possible.

In selecting from among the great number of turbine patents those that appear to have useful features we have had in mind the requirements stated above, and have not selected inventions unless they seem to embody at least one feature that would contribute toward a practical and operative machine.

In writing this review we have drawn on the historical material in the valuable series "Roues et Turbines a Vapeur," by Sosnowski, published in the August, September, October and November, 1896, numbers of the "Bulletin de la Société d'Encouragement pour l'Industrie Nationale," Paris. We have also been materially assisted by the list of English turbine patents in Neilson's treatise, "The Steam Turbine;" and by information kindly supplied by Mr. Robert A. McKee, mechanical engineer steam turbine department, Allis-Chalmers Co., and by the firm of H. Bollinckx, Bruxelles, Belgium.

Real and Pichon, 1827.

This machine operates by impulse and is one of the earliest attempts to produce a wheel to run at moderate speed and at the same time utilize a large percentage of the energy of the steam by the principle of compounding. Certain of the details of the original patent drawing are somewhat obscure, but in preparing the illustration, it has been made to correspond with the text as nearly as possible. The cylinder *A* contains a succession of disks, *B*, which divide the cylinder into compartments. The shaft *F* is turned with a series of steps,

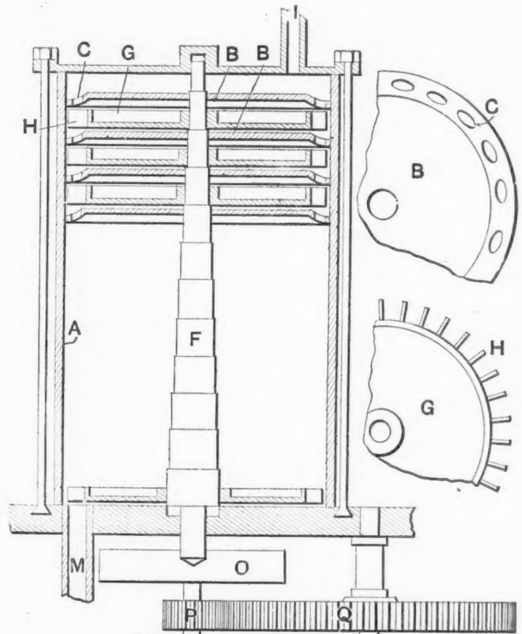


Fig. 1. Real and Pichon Compound Turbine.

upon each of which is carried a turbine wheel *G*, having short radial blades, *H*, around its periphery. Steam is admitted from the boiler through the pipe *I* at the top into the first compartment and flows in the form of jets through a series of openings, *C*, against the blades of the first wheel which runs in the second compartment. The steam next passes through a second series of holes in the second disk and impinges against the second wheel and so on to the bottom of the cylinder, where the steam exhausts through the pipe *M*. The shaft and wheels are carried by a step bearing and power is supposed to be transmitted through the gears *P* and *Q*. The openings, *C*, in the circumference of the disks, *B*, are bored obliquely, so the steam will impinge as directly as possible against the faces of the blades. With this plan the pressure will drop only a few pounds from chamber to chamber, giving the steam a comparatively low velocity of flow. This is substantially the plan used in the Rateau turbine except that in the latter the blades of the wheels are curved, so that the steam acts more efficiently.

Avery Turbine, 1831.

The first steam turbine patent to be issued in the United States was to Foster & Avery for a reaction wheel of the Hero type. Strangely enough, this is one of the few turbine inventions that has been developed and put into actual use, and probably it is the only steam turbine used in commercial work in this country until a considerably later date. There were several of these machines in operation in 1835, at least one of which was used to drive a saw mill at Syracuse, N. Y. In 1901 Prof. John E. Sweet contributed a description to the Transactions of the American Society of Mechanical Engineers, accompanying it by a sketch made from an original drawing of the Avery wheel, reproduced in Fig. 2.

The arm is made, with the exception of the end pieces and knife blades, of two pieces of iron brazed together from end to end at the edges. The openings at the ends of the arms for the steam jets were 1/8 by 1/4 inch. The speed of the tips of the arms was, of course, enormous. Mr. Avery states in his notebook that the speed of the arms of a 7-foot wheel placed upon a locomotive in 1836, which was put upon a railroad near Newark, N. J., and ended its life in a ditch, was

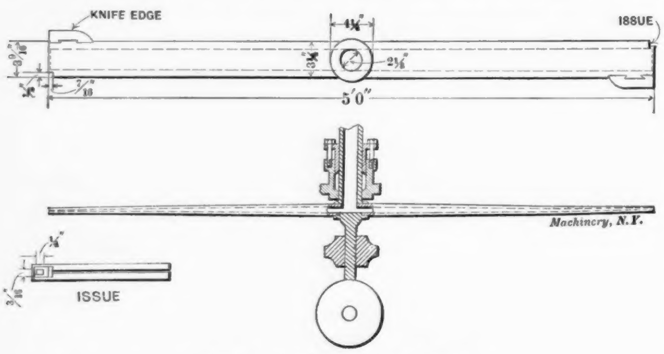


Fig. 2. Avery Reaction Wheel.

at one time 14½ miles a minute at the periphery. A difficulty met with was the end pressure on the hollow shaft, which was overcome by running the end of the shaft against the edge of a wheel set at right angles. The trouble in setting up the packing around the hollow shaft became a serious matter. It was also found that the knife edges at the end of each arm were cut away by the steam and required frequent renewal. The noise also was very objectionable. The economy was about the same as that of the common slide valve engine of that date.

Pelletan, 1838.

This invention is worthy of attention because it is an early attempt to utilize steam mixed with some other gas of greater specific gravity in order to reduce the velocity of flow of the steam and so permit a slower rotation of the turbine wheel. The Pelletan turbine is of the impulse inward-flow type. Steam enters through a valve similar to an injector, so arranged that the steam jet draws in the other gas and combines with it in the nozzle, which directs the jet against the vanes of the wheel. There have been many subsequent attempts to utilize this principle, both by the combination of some other gas with steam, and the combination of some liquid with steam; but none have been successful.

Leroy, 1838.

In commenting on Avery's invention Prof. John E. Sweet said that he had long had the conviction (previous to De Laval's invention) that expanding nozzles applied to the Avery turbine in place of the plain orifices used, would give the benefit of expansion and produce superior results. This would be the case were it not that the speed of a reaction wheel, at best extremely high, would be quickened by using nozzles that would increase the velocity of the escaping steam.

Leroy is perhaps the first on record with this idea of the application of the expanding nozzle. He was a prolific inventor and had definite notions about many features now employed in turbines. Figs. 3, 4 and 5 show three styles of rotating arms that he proposed to use for reaction wheels. The nozzle at *N* is clearly a diverging nozzle, as are also the orifices in Fig. 5. It is uncertain, however, whether he fully understood the principle of the diverging nozzle, because he states in one place that a nozzle in the form of a tube, Fig. 4, will produce a higher steam velocity than a funnel-shaped opening. While this might be true if the funnel flared too much, as seems to be the case, it goes to show that he did not understand the diverging nozzle at all.

Leroy was one of the first to propose a compound turbine. He shows two illustrations of machines—one a reaction and

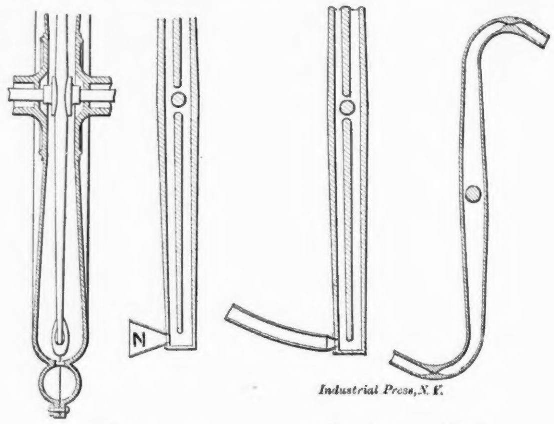


Fig. 3. Fig. 4. Fig. 5.
Le Roy's Reaction Wheels

one an impulse turbine, in which each wheel is encased in a separate chamber. In the reaction turbine steam enters the hollow arms of the first wheel through a trunnion at the center and escapes through openings in the periphery into the first chamber. It is then conducted by a pipe to the second wheel in a similar manner, where it finally escapes into the second chamber, and so on. His compound impulse turbine is entirely similar in principle to the Real and Pichon turbine except that instead of a succession of openings for the steam around the periphery the steam is conducted to each wheel by a single pipe. His drawings of the compound turbine are unpractical, because he makes no provision for the increasing volume of the steam as it expands. The drawings show passages of the same area near the exhaust end of the turbine as at the inlet end.

Pilbrow, 1842.

The inventions of Pilbrow were numerous. He experimented on the flow of steam and determined that for economical results the peripheral velocity of the wheel must be very high, and accordingly devised various arrangements for com-

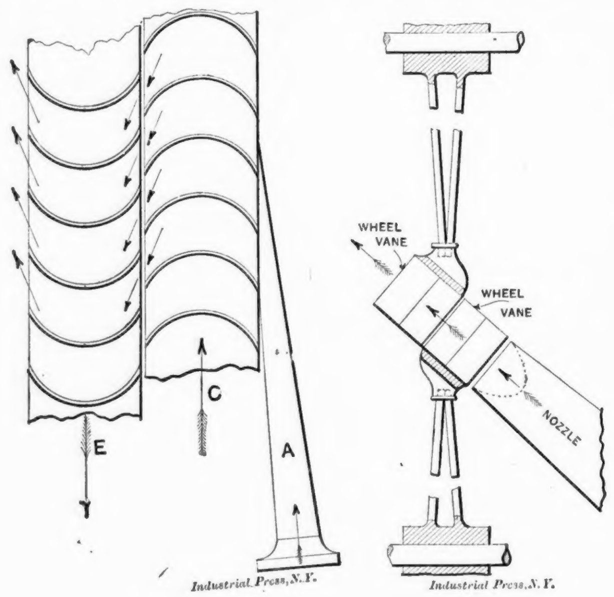


Fig. 6. Fig. 7.
Pilbrow's: Wheels Rotate in Opposite Directions.

pounding with a view to reducing the velocity to a practical rate. In all his compound turbines, however, he adopted the plan of running two or more wheels in opposite directions without stationary guide vanes, as shown in Fig. 6. Here steam enters through the nozzle, *A*, impinging against the blades of wheel *C*, which rotates in the direction of the arrow.

The steam then passes through this wheel and discharges against the blades of a second wheel, *E*, rotating in the opposite direction. Fig. 8 shows how he proposed to carry the idea still further by using several wheels, the alternate wheels rotating in opposite directions. Still another construction that he proposed is indicated in Fig. 7, where the two wheels rotate on parallel shafts, as shown, and have inclined vanes so located that steam from the nozzle will flow through the vanes of both wheels in the direction of the arrows. The buckets are curved, as in Fig. 6, and the wheels, of course,

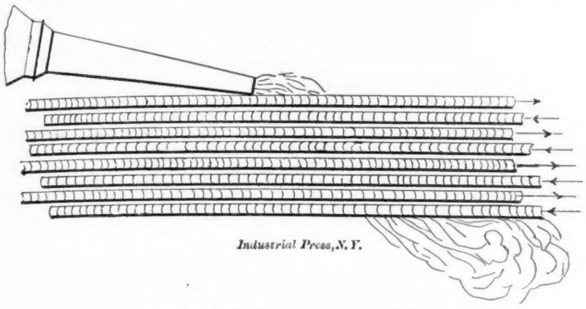


Fig. 8. Pilbrow's Multi-wheel Turbine.

rotate in opposite directions. Another modification of the design shown in Fig. 7 consisted in having several parallel rows of vanes for each wheel, which interlock with those of its mating wheel on the plan of a dovetail. With this construction the steam flowed through the vanes in a direction parallel with the axes of the two wheels. He proposed to couple the two wheels with a parallel rod, so they would keep together.

Pilbrow also proposed a reversing turbine consisting of two wheels inclosed in a casing, and two nozzles, one for each wheel. The nozzles pointed in opposite directions and the wheels would rotate in either direction, according to which nozzle was used.

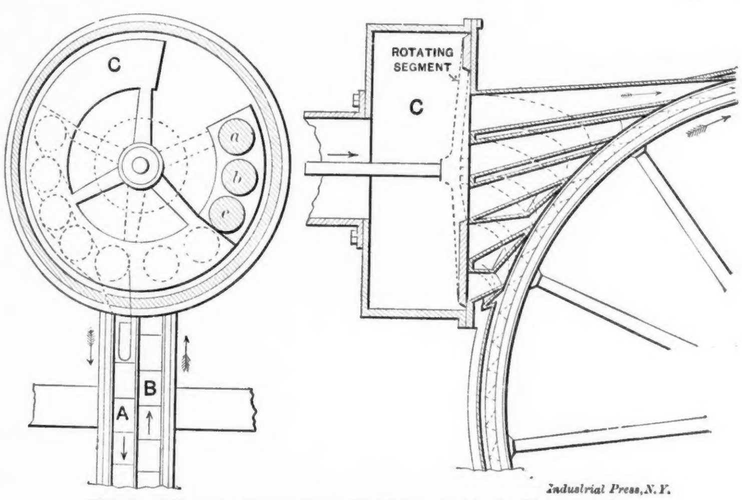


Fig. 9 Pilbrow's Reversing with Valve for Controlling Nozzles

Another interesting invention of Pilbrow is illustrated in Fig. 9. This is a reversing turbine arranged with a number of nozzles that can be shut off or opened successively by means of a rotary valve. The plan of using several nozzles which are brought into or out of action by valves, as used in the De Laval and Curtis turbines, probably here has its introduction, and the invention is of value on this account. Steam enters the chamber, *C*, in which is located a rotating segment that covers or uncovers the nozzle openings, *a*, *b*, *c*, etc. At *A* is the wheel with vanes pointing in one direction and at *B* one with vanes in the opposite direction. Half the nozzles connecting with chamber *C* direct the flow of steam against wheel *A* and the other half against wheel *B*. By rotating the segment, steam can be admitted to either wheel, causing the turbine to revolve in either direction, as desired; and also the amount of steam admitted can be adapted to the power required. A rotating valve of this description is not to be advocated as a durable construction.

Von Rathen, 1847.

The specifications of the patent of von Rathen are noteworthy only in that expansion cones or nozzles are a feature. His turbine is of the reaction type, no different in principle from Leroy's; and like Leroy's, the nozzles are not proportioned at all correctly for good results. He shows sketches of several different shapes of nozzles, some with conical and some with curved walls. He also designed a turbine to rotate in either direction by using a double set of nozzles pointing in opposite directions, with arrangements for conveying the steam through either set, as desired. In the reaction wheel

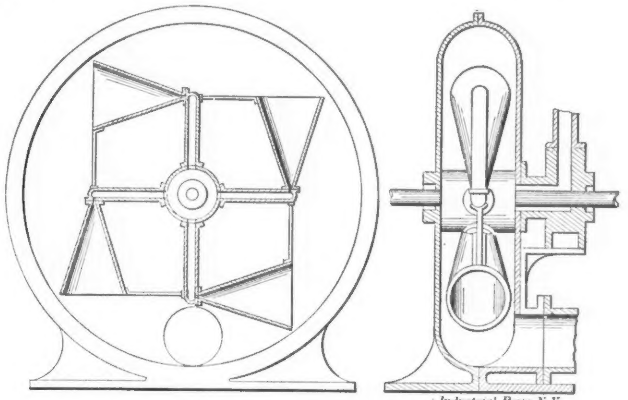


Fig. 10. Von Rathen Reaction Wheel.

shown in Fig. 10 steam enters on one side at the center, flows outward through the radial arms and then discharges through the conical mouthpieces.

Wilson, 1848.

The inventions of Wilson rank among the two or three most important early steam turbine patents. His designs are the forerunners of the present Parsons type. He devised several compound reaction turbines in which the steam flowed through alternating sets of stationary and rotating rings of blades, expanding gradually during its passage through the apparatus. Fig. 11 is a sketch of his most valuable invention. Steam enters at the left, passes through the turbine in a longitudinal direction and exhausts at the outlet at the right. The vanes, *a*, *b*, and *c*, are attached to the drum, *D*, and rotate with it, while *d*, *e* and *f* are stationary guide vanes. The depth of the vanes increases from inlet to outlet, allowing for gradual expansion of the steam. This is really the Parsons turbine reduced to its simplest elements.

Another type—the radial flow wheel—is shown in Fig. 12. Here there are alternating stationary and moving vanes, and the steam flows outwardly through them, at the same time expanding to a lower pressure.

In Fig. 13 is still another type in which there is a single rotating ring of blades marked *B*. The steam is expanded and utilized upon this one ring of blades several times in succession by following a tortuous course back and forth through this ring *B*. Steam enters at *A*, passes through the moving blades to the chamber *C*, then returns through the guide vanes in this chamber to the chamber *D*; again it passes through the guide vanes to the wheel and into chamber *E*;

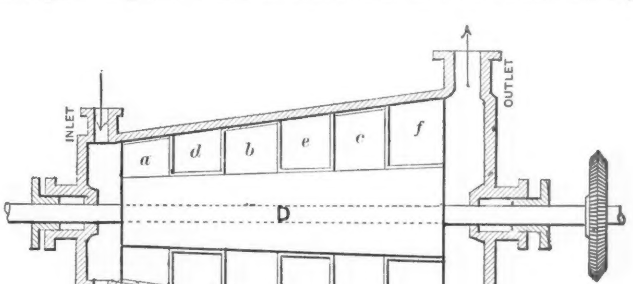


Fig. 11. Wilson's Compound Turbine

then to chamber *F*, and so on. These successive chambers increase in size to allow for the increase in the volume of the steam as it progresses through the wheel, until finally it has

passed around the whole circumference and exhausts at the outlet *G*. This plan of allowing steam to act at different points in succession on a single rotating ring of blades, has since been worked out in various other ways, as subsequent patent specifications show.

Delonchant, 1853.

The speed reduction problem was attacked by Delonchant in the same way that it was later by De Laval; that is, instead of compounding he proposed to allow his turbine to run at

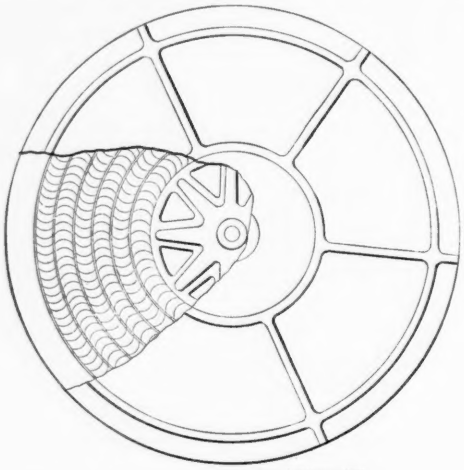


Fig. 12. Wilson's Compound Radial-flow Turbine.

high speed and then used reduction gearing, in the form of the familiar "grindstone bearing." The arbor, *B*, of the wheel, Fig. 14, was supported on the circumference of anti-friction wheels, *C*. In explanation he says: "By the employment of these wheels instead of ordinary bearings, not only the rubbing of the first axes will be replaced by rolling friction but power will also be transmitted to the following parts, without gearing." In the illustration *A* is the rotating wheel; *B*, the arbor and at the center is a steam chest, *D D*, indi-

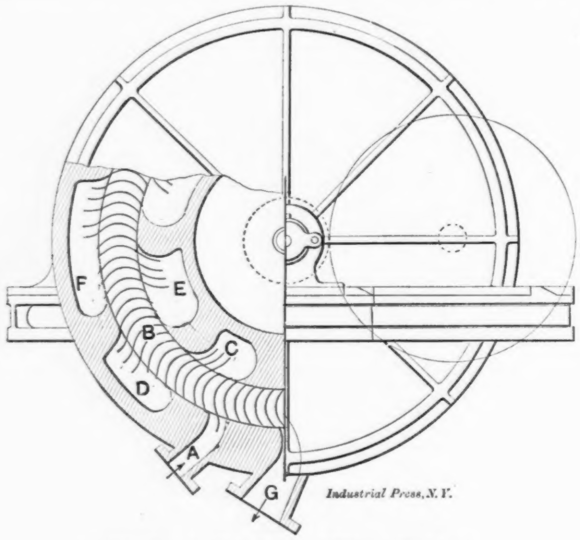


Fig. 13 Another Type of Wilson Turbine.

cated in outline only. Steam passes from the steam chest through the passages *d d d*; and *E* is a ring having passages *e e e*, used in regulating the amount of steam flowing through the wheel. The passages, *d d d*, are so disposed that by rotating ring *E* the passage *e e e* through the ring will be successively cut off from the steam supply, or else opened to the supply. By moving 1-12 of a turn one passage is closed; another one-twelfth closes a second passage, and so on.

Tournaire, 1853.

In this year Tournaire presented to the Academie des Sciences a paper discussing the merits of compound turbines both of the impulse and reaction types. There is a copious extract from this paper in the Bulletin de la Societe d'Encouragement pour l'Industrie Nationale for September, 1896, and the facts explained by him as essential to a successful turbine are so in accordance with modern practice as to place him among the leading inventors. He says: "To overcome the difficulties of high velocities the vapor or gas should be made to lose its pressure in a continuous and gradual manner, or by successive fractions, by causing it to react several times upon the floats of turbines conveniently situated. Since the differences of pressure are considerable it is not difficult to recognize the necessity for a large number of successive turbines in order to sufficiently annul the velocity of the fluid jet. In spite of the multiplicity of parts the device must be simple in its action and susceptible of great exactness in construction." Tournaire believed he fulfilled these condi-

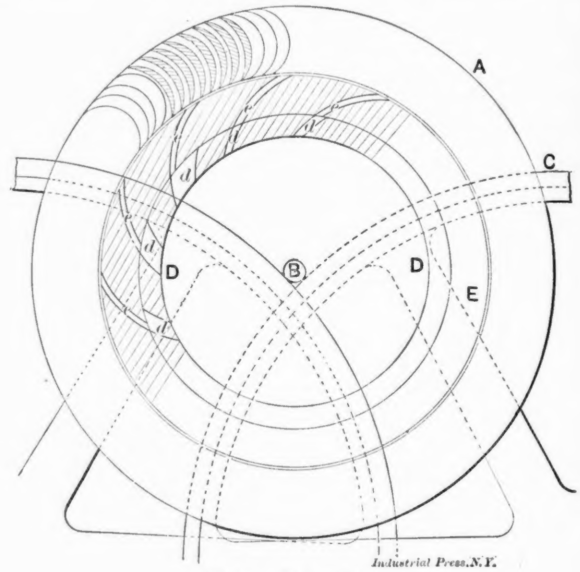


Fig. 14. Delonchant.

tions by means of a machine composed of several wheels, shafts rotating on the same axis and driving the wheel which was to transmit the motion, by means of pinions. A plan of the buckets and vanes is given in Fig. 15, where *G G G* are the rotating elements and *V V V* the stationary elements. He describes the construction of the turbine in detail, but these structural features are of little interest at the present time. It is to be noted, however, that he appreciated fully the necessity for expansion. He says: "As the vapor will expand in proportion as it passes from the wheel buckets and directing rings, it is necessary that the passages between them become larger and larger." He also suggests losses from leakage, saying: "A part of the fluid escaping between the spaces which it is necessary to leave between the fixed and movable parts, will exert no action upon the turbine, nor will it be guided by the directing buckets. Shocks and eddies will be produced at the entrance and exits of the buckets." Again, "The friction which the narrowness of the channel will render considerable will absorb an appreciable part of the theoretical work." As to the structural features he suggests among other things, that "the cogs of the pinions which will turn with great rapidity, should work very evenly without shocks and jolts," and proposes the use of helicoidal gears. His turbine, as well as some of the others already described, is a vertical turbine rotating on a vertical axis.

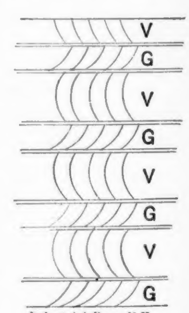


Fig. 15. Plan of Vanes in Tournaire's Turbine.

Girard, 1855.

Three years later a turbine was patented having features that are of very doubtful utility but nevertheless of interest. Steam enters pipe *C*, Fig. 16, and flows upward through the curved annular passage, *D D*, where it enters the rotating wheel near the center. Girard in his invention endeavored to do away entirely with the stationary guide vanes and so eliminate the friction of steam against them. Accordingly the steam, starting at the center of the wheel, flows upward in a radial direction and impinges against curved rotary vanes at *a*. These vanes increase in width, allowing the steam

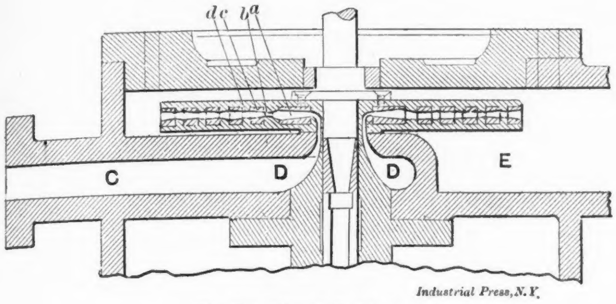


Fig. 16. Girard Turbine.

to expand somewhat until it enters an annular chamber, *b*, which is a part of the rotating wheel but which contains no vanes. The supposition is that steam will come to rest in this chamber, then flow radially outward again through guide vanes at *c*, coming to rest at *d*. The error in this arrangement is evidently in supposing that the steam will come to rest. Instead the steam would flow continuously through the various passages and the wheel would not absorb any more energy than if simply discharged through orifices on the circumference, as in a Barker's mill. This patent is mentioned because it is possible for a radial outward-flow wheel to be constructed without guide vanes, the steam entering the moving passages in radial directions; but the wheel would be quite inefficient.

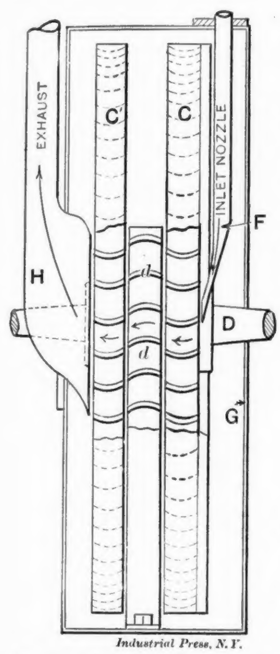


Fig. 17. Hartman's Compound Impulse Turbine.

John and Ezra Hartman, 1858.

Standing in importance with the inventions of Wilson and Tournaire are the English and American patents of the Hartman brothers, from the drawings of which Fig. 17 is made. The patent relates to a "mode of obtaining motive power by causing steam or air to impinge upon a series of chambers with curved bottoms ranged around a wheel at or near the periphery thereof; and second, the general construction and arrangement of machinery or apparatus for obtaining motive power." Fig. 17 shows the most important modification of the patent, of which the following is the inventor's description: "This represents a detail of the third modification wherein we propose to employ two wheels, *C C'*, both wheels being fast on one shaft, *D*. A space is left between the contiguous faces of these wheels for the reception of four or more returning chambers, *d d*, the bottoms of which are curved in a direction opposite to that of the bottoms of the chambers in the wheels. These chambers in other respects are precisely similar to those in the wheels and are fitted to a rim which is bolted or otherwise secured to the interior of the casing, *G*. The jet pipe, *F*, is at one side of the wheel and the discharge pipe, *H*, on the opposite side of the second wheel.

The jet pipe on being first introduced impinges against the curved bottoms of the chambers in the wheel *C*, and is thence diverted against the fixed chambers, *d d*, whence it is again diverted on to the curved bottoms of the chambers in the second wheel, *C*, and finally passes off by the escape pipe, *H*.

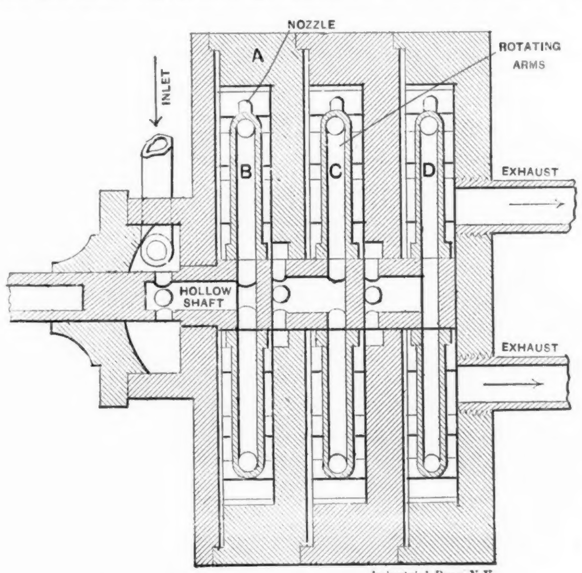


Fig. 18. Monson's Compound Reaction Wheel.

Charles Monson, 1862.

We have already illustrated types of simple reaction wheels but a search of the patent records shows that several inventors have attempted to improve on this arrangement and produce a turbine which will run at slower speed, by having a succession of simple reaction wheels, each one in separate chamber and arranged so that steam issuing from a wheel into its chamber will then pass through to the next wheel, and so on. This in substance is the design of Monson's turbine, shown in Fig. 18. The leading specification of his patent is as follows: "A repeating rotary engine constructed in a manner so as to operate substantially as described; namely, of two or more sets of curved arms, *B*, *C*, *D*, or their mechanical equivalents; a series of two or more tight chambers or passages, *A*, and a shaft or its equivalent divided into separate chambers and provided with induction and escape passages." The course followed by the steam will be evident from the engraving.

* * *

A PROCESS FOR COPYING PRINTED PICTURES.

JOSEPH C RILEY.

The so-called "metallic" paper used for steam-engine indicator cards is familiar to all mechanical engineers. It has a smooth surface, chemically prepared so that black lines can be drawn upon it with pencils made of brass, copper, silver, aluminum, or any of the softer metals. When used on the indicator, it receives the faint line drawn by a brass point at one end of the pencil arm, and its special advantage over ordinary paper is that the metallic pencil slides over its surface with very little friction, and keeps its point much longer than a graphite pencil.

Another property, not generally known, is possessed by this paper, and may possibly render it of great value for a purpose quite different from that for which it is now manufactured. It can be used as a transfer paper for copying engravings or sketches, or in fact anything printed or written in ink or drawn in pencil. If a sheet of it is laid face downward upon a printed picture, and then rubbed hard upon the back with a blunt pointed instrument, such as the rounded end of a pocket-knife handle or a smooth piece of ivory, a copy of the original picture will be transferred to the indicator paper. The copy is produced by removal of ink from the print, but the amount removed, although enough to make fairly dark lines, is so small that the original is left practically uninjured and nearly as dark as before. Firm pressure of the tool is necessary, but pressure alone will not effect the transfer; abrasion of the ink surface is necessary, and it is secured by the very slight slipping of one sheet over the other, caused by local stretching of the paper under the point of the rubbing tool. Any more than minute, local slipping must of course be prevented, or a blurred copy will result. The transfer paper should be protected by a thin piece of cardboard laid over it, and the two should be held tightly under the thumb and forefinger of the left hand while the tool is rubbed all over the cardboard, from side to side and top to bottom. Less than a minute is sufficient time for transferring a cut from two to two-and-one-half inches square; larger ones require longer time and the exercise of care to prevent stretching and consequent distortion, the difficulties becoming so great that the process seems at present limited to pictures not over four inches square. A corner of the transfer paper may be turned up for examination at any time.

Line drawings printed from relief plates, or pictures with

sharp contrast of black and white without any half-tones, give the best copies. Very few half-tones can be transferred satisfactorily; almost all give streaked, indistinct copies and many of the results are worthless. This process is not recommended for copying half-tones.

The transfer taken off as described is a *reverse* of the original print, "a view of the opposite hand," as draftsmen say, and any lettering on it will read backward. If the question of right and left is not important, this reversal will seldom be objectionable, for it is easy to read backward what few letters generally occur. However, if desired, the paper may be held up to the light and examined from the back, or placed before a mirror and viewed by means of its reflected image, when the true relations of right and left will be seen. Moreover, if sufficiently important, an exact counterpart of the original may be taken from the reversed copy by laying another sheet face downward upon it and rubbing on the back of the fresh sheet just as was done in making the reversed copy. The impression thus produced will be fainter than the first, but almost always it can be made dark enough to show a distinct outline which may afterward be retouched with a lead pencil.

Fig. 1 shows a reversed copy transferred from a picture in a steam-engine catalogue. The original is in black ink on plate paper and measures 2¾ by 4 inches. It is reproduced in the columns of MACHINERY by printing from a half-tone plate, photographically prepared, and the lines do not appear so clear as in the original. However, the reader is assured that the copy in question is clear in detail and about half as dark as the original picture from which it was taken; and that, furthermore, not enough ink was removed from the original to cause any perceptible change in appearance.

Fig. 2 shows a reversed copy, and Fig. 4 the true copy made from it in the manner described. The second is but little fainter than the first, and both possess a certain artistic softness and quality of line not found even in the original.

Fig. 3. was transferred from a tracing made with Higgins' indelible drawing ink. The copy was made in about forty seconds, and is both dark and clear.

Fig. 5 and Fig. 6, which was produced from it, are transfers of handwriting in Carter's Koal Black ink which had been dry more than two months. This process offers a quick means of obtaining facsimiles of signatures without injuring the documents to which they are attached. It will doubtless be appreciated by collectors of historic autographs—perhaps also by persons of another, not strictly legitimate vocation.

For indicator cards, the paper is prepared by coating one surface with a suitable compound, usually zinc oxide mixed with a little starch and enough glue to make it adhere. After drying, it is passed between calender rolls under great pressure. The various brands manufactured for the trade, though perhaps equally good for indicator diagrams, are not equally well suited for copying. A paper supplied by the Crosby Steam Gage & Valve Co. was used for the cuts illustrating this article. Its surface appears to have just the quality required for transferring ink and preserving clear lines, but the body of the paper is a little softer than it should be, and, unless care is taken, it is likely to stretch when copies over two inches square are attempted. If paper of firmer texture could be prepared with the same surface finish, probably much larger copies could be produced.

Other kinds of paper, notably the heavy plate papers used for some of the best trade catalogues possess this transfer property to a slight degree, though they will not receive marks from a metallic pencil. The latter feature would seem to recommend them for transfer purposes, making them less likely to become soiled by contact with metallic objects, but so far no kind has been found which will remove enough ink to give copies anywhere near as dark as the indicator paper.

In choosing pictures for illustration, the writer selected those which could be copied with best results. Fairly good transfers can be made from almost any common printer's ink, but some inks copy much better than others, and some yield only the faintest impressions. The length of time since a picture was printed does not seem to determine its copying quality. Some very old prints can be copied better than new ones; in fact, it was by accidental transfer to an indicator card from a book nearly a hundred years old that the peculiar property of this "metallic" paper was discovered.

The reader has probably noticed in examining old books, that reversed impressions of engravings are often found on the fly leaves or tissue sheets which face them. This is probably due to chemical action between the ink and the paper; it is not the result of a physical transfer, for usually the ink was dry before the book was bound, and since that time it has not been subjected either to friction or to great pressure.

How many draftsmen and engineers have often wanted private copies, however faint or imperfect, of small details which were too complicated to remember, and which would require too long to trace; how often persons reading in any branch of science would like to make copies of pictures or diagrams from books which they cannot buy, or which are too cumbersome to have at hand when wanted. A ready means of supplying such demands with exact copies of the originals, however intricate, is afforded in this frictional transfer process. For small copies the results are already very satisfactory, and it is believed that by improvement the process can be made of value for work of a much more pretentious character.

Since the above was written, it has been found that much better copies can be made by following the directions below, instead of those already given. Lay the metallic transfer paper, *face up*, upon at least a dozen sheets of blank paper, and lay the print *face down* upon it. On the back of the print, place a sheet of heavy paper, or thin cardboard, and run the rubbing tool over this protecting sheet. In this manner it is comparatively easy to prevent slipping, and prints eight or ten inches on a side may be copied satisfactorily.

* * *

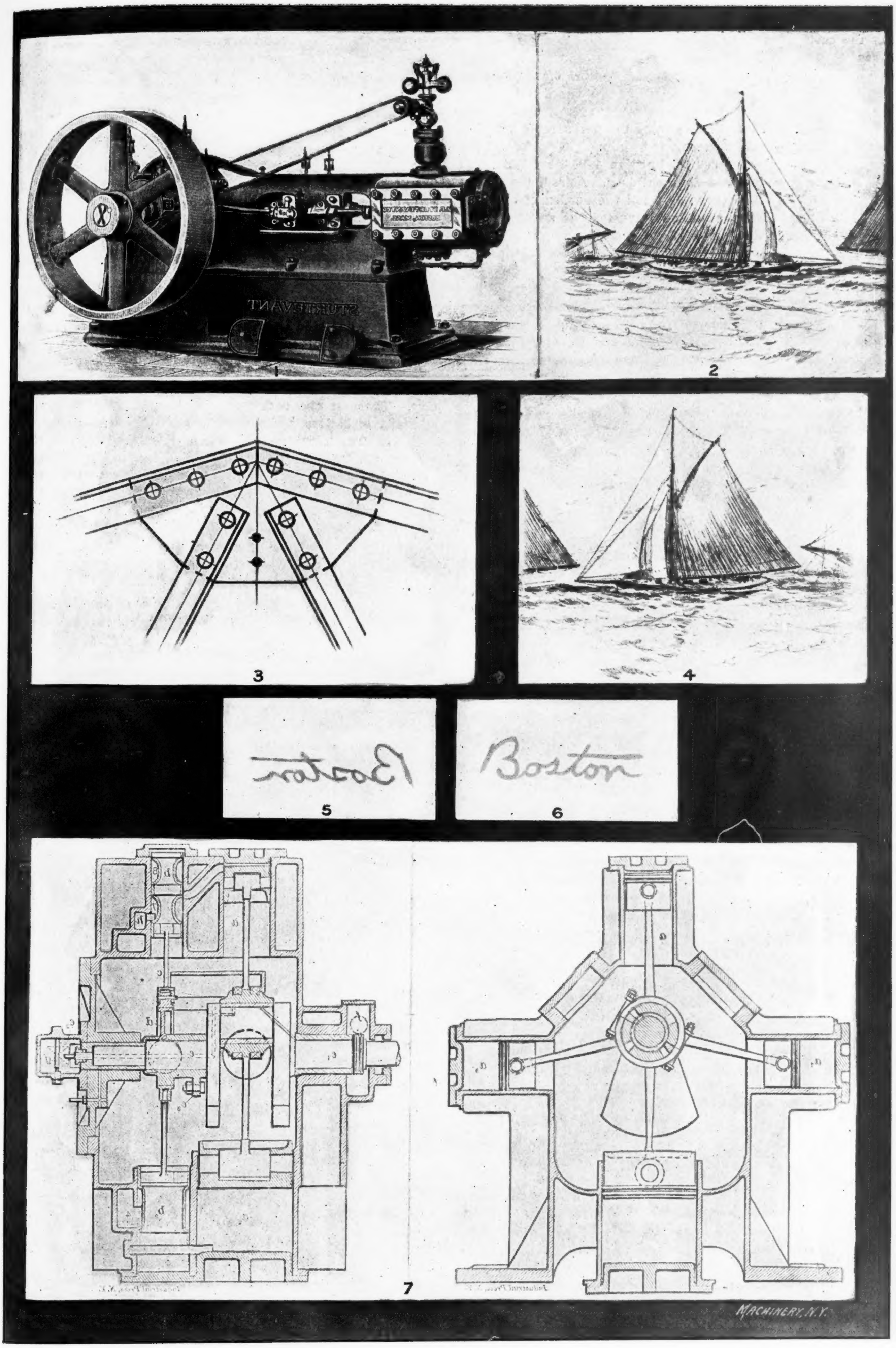
ESSEN AND THE KRUPP WORKS.*

In spite of its fame and its situation on one of the main highways of Europe, Essen is little known. "There is nothing to see except the works. In 1811, when the first smelting furnace for casting steel was set up by Peter Friedrich Krupp, the population of Essen was under 4,000. In 1901 it was 183,500, out of which the Krupp contingent numbered about 84,000. At the same date there were more workmen's dwellings built by the firm than there had been inhabitants when it was founded. Now, this and a great deal more is essentially the work of one man, and it is unparalleled in the history of industry. It must not be supposed, however, that the Krupp family created Essen out of the wilderness, as some places have been created by industrial enterprise. The place is ancient and has a history. In the Middle Ages it was a walled city; the shape of the central quarter, the narrow and winding streets, and the names of the four gates survive as reminders of the past, but no other vestiges remain. For centuries also Essen was famous for the manufacture of firearms. The command of running water and of coal, which is mentioned in connection with Essen as early as 1317, accounts for the development of these industries. They appear, however, to have declined gradually during the eighteenth century, when the town fell into a decayed condition. Modern Essen may be said to date from the evacuation of the French in 1813, which almost coincides with the original foundation of the Krupp works and marks the beginning of a new era.

The Krupp Family.

Peter Freidrich Krupp was born in 1787 and went as a youth into some iron works at Sterkrade, which came into the possession of his grandmother in 1800. These works had been started in 1780 and were among the earliest in the district; they still give their name to the large iron and steel business known as the Gutehoffnungshütte of Oberhausen. Here young Krupp worked at the invention of a process for casting steel and committed the reprehensible imprudence of marrying at 21. He went to Essen, where some iron works that had been built for the abbess in 1790 were at this time acquired by the firm, which also became the owners of the Sterkrade works. This connection may have been the reason of Krupp's settling in Essen, but at any rate he soon set up for himself, and at the age of 23 he purchased a small forge worked by water power, where he devoted his time to secret

*Abstract of article in Consular Report No. 2009, taken from the London Times.



Half-tone Reproduction of Impressions on Metallic Paper, taken from Printed Engravings. Reproduction Full Size. See "A Process for Copying Printed Pictures."

experiments in smelting steel in small crucibles. To this day the casting of crucible steel is the great specialty of the Essen works. A son, Alfred, was born to the young couple in 1812, when Friedrich Krupp was 25. Want of means compelled him to enter into partnership at this time, and in 1815 the firm announced that they were prepared to accept orders for cast steel; but as no orders came the partnership was dissolved and he was left to struggle on alone. This he did for some years, but with difficulty, until in 1826 he fell ill and died, leaving a widow and four children. Alfred, the eldest, was then 14, and on his shoulders fell the burden of carrying on the business. His father had intrusted the secret to him and taught him the trade. Alfred left school at once and took his place in the shop, where he worked at the furnace and the forge harder than his own handful of journeymen, and for years made no more than sufficed to pay their modest wages. "For my own toil and pains at such an early age," he said afterward, "I had no reward but the consciousness of doing my duty."

Few schoolboys have entered on the struggle for life with such a laborious inheritance and fewer have emerged so victoriously after so long a probation. For twenty-five years the fate of the concern hung in the balance, and success became assured only after the London Exhibition of 1851. Four years previously the first gun, a 3-pounder of cast steel, had been finished. Thenceforward the story is one of rapid and almost continual progress. In 1853 the manufacture of weldless steel tires was begun. Ten years later the first workman's colony was built, and not long after Herr Krupp found himself in a position to obtain command of raw materials, and so placed the business in a self-sufficing and impregnable position by the purchase of iron mines and blast furnaces, presently followed by coal mines. He died in 1887, having been for sixty years the head and for forty years the sole proprietor of the works, which then passed to his only son, the late Friedrich Alfred Krupp. They have been greatly extended since by the addition of other works and mines and, in 1902, the Germania shipbuilding yard at Kiel, but are still, with all their branches and appendages, the sole property of the family. They are managed by a board of directors. On April 1, 1902, the total number of persons employed at the various works was 43,083, representing, with their families, a population of about 150,000. The numbers were thus distributed:

Steel works at Essen	24,536
Gruson works at Buckau	2,773
Shipbuilding yard at Kiel	3,987
Coal mines	6,159
Blast furnaces, proving ground, etc.	5,628
Total	43,083

The old-fashioned little house of five rooms in which Alfred Krupp's parents lived and worked and brought up their children, hard by the original forge, still stands at the entrance to the works, and a tablet on the door refers, modestly enough, to the privations, efforts, and anxieties which attended the founding of the business and overshadowed its career for many years. The contrast between the small, struggling beginning and the immense eventual achievement stands embodied before one's eyes with a dramatic significance which cannot fail to impress; but if one inquires the origin of other manufacturing concerns one finds that with rare exceptions—and those of recent date—they were started in much the same manner, went through similar early struggles, and survived by virtue of the same qualities.

The Town

The English town which most naturally suggests itself for comparison with Essen is Sheffield; and there are many points of resemblance between them. Both lie on the same hilly sort of ground that goes with the presence of coal; both have narrow, old-fashioned, irregular streets; both have charming country on their outskirts, though in this the advantage lies with Sheffield; and both manufacture the same things on the same scale. On the other hand, Sheffield is more than twice as big, it is a much older manufacturing place, and has a greater variety of manufactures. The ancient cutlery industry, file cutting, and electroplating give it a special character which is lacking to Essen. Take them as they stand, however, for what the comparison may be worth, and it must be admitted that the German has rather the best of it. The site of the Krupp works on the lower side of Essen, in and out out of the town, is curiously like that of the great Sheffield works—at Cammell's, Brown's, Firth's, and Vickers and Maxim's—which lie all together in a similar position, and probably occupy even more ground between them. They certainly make more smoke, or it hangs more persistently about. Sheffield is the grimiest of all our manufacturing towns, with the possible exception of Gateshead, and a large part of it is generally wrapped in a pall which neither London nor Manchester can equal. America alone, with her genius for surpassing everything, easily beats it. Compared with the inferno of Pittsburg and the lesser, but still more grimy and squalid, hells up the Monongahela Valley—Homestead, Braddock, and the rest—Sheffield is clean and Essen a pleasure resort, in spite of the fifty or sixty tall Krupp chimneys that flank it on one side and various other factories, with sundry coalpits, on the other.

The Industries.

Apart from Krupp's the industries of Essen are not extensive. There is one considerable iron works which makes a specialty of boilers, a chemical factory, breweries, and several coalpits. The town lies over the coal bed and the mines run underneath it. The great Rhine-Westphalian Coal Syndicate —probably the most important industrial combination in Germany—has its headquarters at Essen. The products of the Krupp works are very varied. Their firm is chiefly associated with war material, but they minister no less to innumerable peaceful purposes. All kinds of finished and half-finished material for railways, ships, engines, tools, mills, and other industrial appliances are turned out in large and small quantities. The war department turns out guns of all sorts, of which 39,876 had been delivered up to the end of 1901, projectiles, fuses and ammunition, rifle barrels, and armor. The manufacture of offensive and defensive material is a lucrative game of see-saw, in which the governments of the world are pawns in the manufacturer's hands. It is like the burglar and the safe. The scientific possibilities are infinite, and the experts have only to turn their attention to each in turn and their customers must follow. A more powerful gun, a more vicious projectile, or a new ammunition, and the old defenses are obsolete. The governments hasten to provide themselves with the latest instruments of destruction. Then the metallurgical chemist brings a new hardening process or a new alloy on the scene and produces armor which defies the latest weapons; and again everybody must have it, or questions are asked in Parliament. Thus it happens that the Essener-Hof—that most exclusive of hotels, which stands hard by the works and is reserved for distinguished customers—never lacks guests from all parts of the world. They are the emissaries of their governments, watching the execution of orders. There is not much fear that any of the great powers will outstrip the rest to an alarming extent. These matters are, of course, profound trade secrets; but somehow or other Essen knows pretty well what is going on at Elswick and Sheffield, which return the compliment, and all three have made up their minds about the merits and defects of the new French gun before it has been delivered.

* * *

Many young draftsmen who are desirous of learning to letter drawings neatly, would undoubtedly appreciate, for practice, a stipple paper with rows of dots in slight relief. The upright rows should make an angle of 60 degrees to the horizontal, the tops, of course, being inclined to the right. The spacing of the rows of raised dots should be about 1-128 inch each way, the distance of 1-128 inch forming the unit for proportioning the letters. Thus if lettering in the familiar *Engineering News* style, the body of lower-case letters would be made, say, 8 spaces high and the total height would be 12 spaces in descriptive legends. The proper slant of the letters would be naturally formed by the pencil point following the inclined rows of dots, and horizontal lines in the same way. A few weeks practice on such paper would do much to cultivate the proper stroke and sense in proportion that is often sadly lacking with draftsmen when it comes to neat lettering

CHARTS IN DESIGNING.

JOHN S. MYERS.

John S. Myers.

Charts which are used for recording data or for assisting the designer in proportioning his work or in making calculations, may be classified, according to the purpose for which they are intended, under two general heads, *i. e.*, Record Charts and Calculating Charts.

To the first class belong cards from all recording devices and diagrams of any kind laid out from known values, such as graphical representations of results of tests. Such charts may constitute a record pure and simple; they may be for the purpose of better showing the existing relations of the quantities involved, for ascertaining mean, intermediate or proportional values, or they may be developed with a view to discovering losses, irregularities, errors, etc.

The following development of one of a series of tests on the power required to drive rivets is a fair illustration of the applicability of record charts:

Experiment* on ¾-inch rivets, holes punched 13-16 inch at top, about ⅞ inch at bottom, 1 8-20 inch grip, about 1½ inch projection of shank before driving. The rivets were driven on an Allen riveter, the frame having been previously calibrated as a spring balance by measuring the deflection in thousandths of an inch with a micrometer, for known loads suspended from the die. Chart No. 1 shows the calibration of the frame.

In chart No. 2 the full curved line represents graphically the results of experiment as tabulated. The dotted curve represents allowances for efficiency and inequalities in length of the rivet, plotted with a view to determining the energy required for a power driven machine. In this test the mean average pressure during period of driving was 40,925 pounds. The distance passed over under this mean pressure was 29-64 inch.

$$\frac{40{,}925 \times 29}{64 \times 12} = 1{,}545 \text{ ft. lbs. of energy.}$$

With allowances as per dotted line $= \dfrac{38{,}000 \times 1.25}{12} = 3{,}960$ ft. lbs. If exerted every 3 sec. the H. P. to drive alone $= \dfrac{3{,}960 \times 60}{33{,}000 \times 3} = 2.4$. Of course allowances would have to be made for other losses and for extra stroke.

The uses which have developed for charts have become as numerous as the different branches of industry with which they are associated. Their construction, when taken up in detail, is even more varied than their uses. Cold figures never convey to the mind as clear a conception of relative values as a graphical representation, and in the case of experiments the tabulated data often brings to view points when charted, which would not otherwise be noted.

Frequently a record chart is used to interpolate between known values, obtaining unknown ones, as was the calibration of the riveter frame in the foregoing example.

Similar to the last mentioned class of charts, but closely allied to Calculating Charts, belong stress diagrams and all kindred matter in the art of graphostatics so much used in the determination of stresses in framed structures, bending moments in beams, etc.

Calculating Charts may be defined as those which express mathematical relations of quantities. They are of two varieties: Those upon which certain mathematical operations may be performed according to any sequence, the quantities being either concrete or abstract and of any denomination and measure desired; and those designed for dealing only with concrete numbers of definite measure and denomination, the quantities involved having a fixed mathematical relation and sequence.

Under the first subdivision, if this liberty of classification be permissible, come all forms of calculating instruments, such as the slide rule, Sexton's omnimeter, Thatcher's calculating machine, etc. The principles upon which these operate are quite generally known, leaving little to be said in this connection. There is, however, a spirit of distrust regarding the accuracy of calculations performed upon a slide rule far too prevalent. Because one reads from the rule 975 pounds as the weight of a casting and the actual multiplications give 974.235 pounds, is that any reason why the rule should not be used for estimating weights? In all probability one would set the weight down as 980 pounds for sake of even figures, and if a casting it might come out of the sand weighing over 1,000 pounds.

In calculating stresses, for instance, who cares for a hundred pounds more or less? If the assumed fiber stress be 10,000 pounds per square inch, an error of even 500 pounds is only 5 per cent. The rule has a wide sphere of usefulness

TABLE I

No. of Rivets.	Deflection of Frame.	Pressure at Die, pounds.	Total Length of Rivet Head to Head	Height of Head being Formed.	Remarks.
1	.016	6000	$3\frac{7}{64}$	$\frac{29}{32}$	End stove up.
2	.022	9000	$2\frac{59}{64}$	$\frac{25}{32}$	End stove up ⅛″ more.
3	.036	15000	$2\frac{27}{32}$	$\frac{3}{4}$	Head commencing to form in die.
4	.063	26000	$2\frac{25}{32}$	$\frac{23}{32}$	Head formed in part only.
5	.095	39000	$2\frac{23}{32}$	$\frac{21}{32}$	Head not completely formed.
6	.150	62000	$2\frac{11}{16}$	$\frac{5}{8}$	Fairly well formed head.
7	.208	82600	$2\frac{43}{64}$	$\frac{5}{8}$	Better head, hole well filled.
8	.214	87800	$2\frac{21}{32}$	$\frac{5}{8}$	Some hotter than last rivet; good head.

and those persons who cry out so against it as an unreliable instrument are only lacking in judgment as to where and where not extreme accuracy is required.

The settings, Figs. 1 and 2, next page, illustrate the location of two much used constants which may be applied to any slide rule, and after used a short time their utility will become apparent.

Explanation: Set 4 on the *B* scale under π on the *A* scale; at left index make mark *a* on the *C* scale. See Fig. 1. Set second 4 under π and mark a_1.

Setting *a* or a_1 to any diameter on the *D* scale gives the area on the *A* scale opposite either index; setting runner to length on *B* gives volume on *A*.

Set the rule as above, Fig. 1, and the runner at 283 on the *B* scale as indicated at *x*; set the right index of the slide at this line *xx* and at left index make mark *W*, Fig. 2, on the *C* scale. Mark second *W* in line with the middle 1 of the *A* scale.

Setting either *W* to any diameter on the *D* scale gives the weight per inch of round steel bars on the *A* scale, setting runner to length on *B* gives weight of bar.

As an aid to the memory for the uses of these points, *a* stands for areas and *W* for weights.

Calculating Charts.

Taking up Calculating Charts in detail, simple mathematics may be divided into three elementary operations, each class consisting of a couplet in which the one member is the inverse of the other, viz.: addition and subtraction; multiplication and division; raising to a power or extracting a root.

Chart No. 3 illustrates how the operations of addition and subtraction may be performed graphically. Following the broken line in the direction indicated by the arrow heads represents operations as follows: $7 - 4 = 3$, $7 + 4 = 11$, $7 + 4 + 4 = 15$, $9 + 2 = 11$, $9 + 2 + 4 = 15$. Following these lines in the opposite direction would perform the inverse operation. It will be noticed that when the zero line is crossed to find the next value, addition is performed but when the zero line is not so crossed subtraction results, *i. e.*, the quantities represented by the diagonal lines on the same side

* The writer is indebted to Mr. A. L. Goddard, M. E. of the Edison Laboratories for the tabular data of this test.

of the zero line, as the quantity it is desired to combine with are negative.

Chart No. 4 illustrates in a similar manner the operations of multiplication and division. The arrows indicate the following: $6 \div 2 = 3$, $6 \times 2 = 12$, $6 \times 2 \times 1.25 = 15$. The line *A-A* represents multiplication by 2 combined with addition of a constant whose value is also 2, thus: $6 \times 2 + 2 = 14$. This line is drawn parallel to the multiplier (in this case 0-2) and has its point of origin at the constant. Line *B-B* represents division by 2 with addition of a constant 2, thus: $12 \div 2 + 2 = 8$. It will be noticed that in addition and subtraction the parallel diagonal lines have their origin at the value they represent, and their terminus at a similar value on the side adjacent, if the scale on that side were reversed; while in multiplication and division the lines are divergent and have their origin at the common zero point of the two scales.

In Charts Nos. 3 and 4 the operations may be carried on continuously within the range of their readings, thus: $[(9 + 2 = 11) + 4 = 15] - 2 = 13$, and similarly in Chart No. 4 $[(6 \times 2 = 12) \div 1.5 = 8] \times 1.25 = 10$. This is dealing with abstract numbers, however. A single line chart handling concrete values will combine two quantities and give the result of whatever the operation may be. A chart having two sets of sloping lines will combine three values giving the result. If more than three values are to be combined, a multiple chart, as illustrated by Chart No. 5, may be used. The following is a concrete example of the last-mentioned chart, illustrating plain multiplication and division. (See Chart 6.)

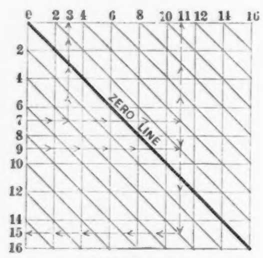


CHART NO. 3

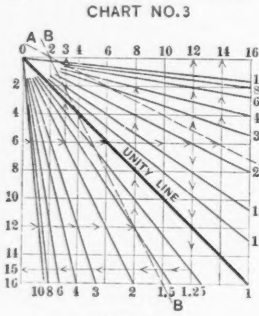


CHART NO. 4

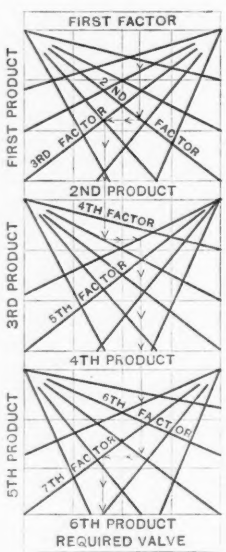


CHART NO. 5

Machinery, N.Y.

Tank Chart.

Required: the thickness of tanks of various diameters and heights for containing different fluids. The formula for thin cylinders is as follows: $t = \dfrac{pd}{2sy}$, where t = thickness in inches, p = pressure in pounds per square inch, d = diameter in inches, s = allowable working stress in pounds per square inch and y = the efficiency of the riveted joint.

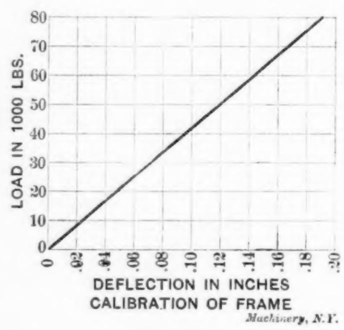


Chart No. 1.

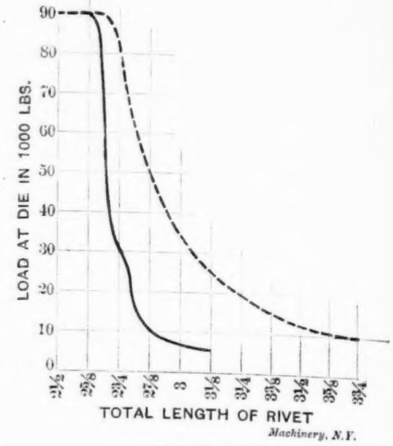


Chart No. 2.

Let D = diameter in feet, H = head in feet, and G = specific gravity of fluid; then

$$\frac{.433\, H\, G\, 12\, D}{2\, s\, y} = 2.598\, \frac{H\, G\, D}{s\, y}$$

In operations of multiplication and division the order in which the factors are taken does not affect the value of the result; it is therefore advisable to choose those quantities which are most constant for any given problem as the first factors of the chart. In this case the order has been chosen as follows: diameter, specific gravity, stress, efficiency of joint and head.

Next in order of importance comes range of readings and scales. It is always desirable to make the range of a chart as great as is consistent with reasonable accuracy. In the case under consideration the range of diameters has been chosen between 6 and 120 feet, but in order to secure this range three different scales have been used; 2 feet per space from 6 feet up to and including 20 feet; 5 feet per space from 20 feet up to and including 60 feet; 10 feet per space from 60 feet up to and including 120 feet. (Chart No. 6.)

This change of scales necessitates three different points of origin for the lines representing the second factor, but the error of interpolation is thus kept within reasonable limits without making a chart of abnormal proportions.

To aid one in deciding upon appropriate scales and limits of readings for the other factors and products, it is well to tabulate these factors and their resulting products; first choosing assumed limits of readings for the intermediate

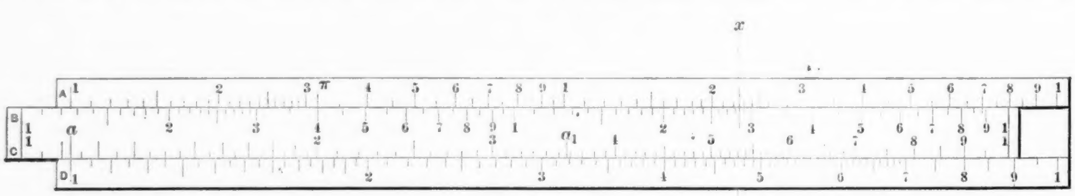


Fig.1

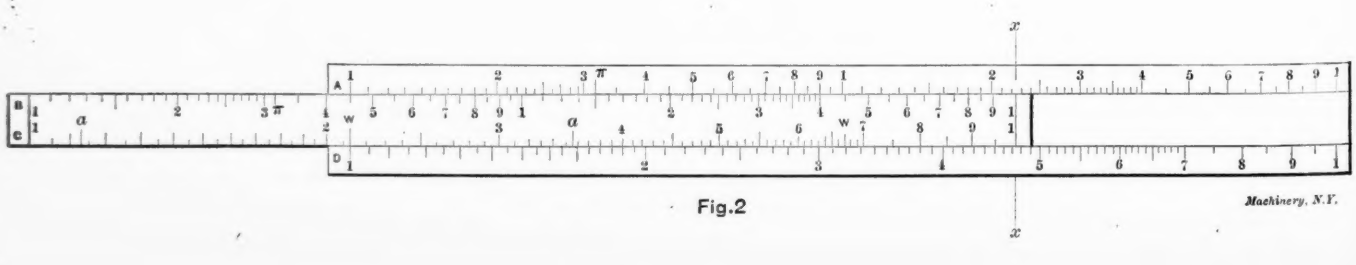


Fig.2

quantities which will produce the minimum final value, then vice versa, and lastly, what may be considered a practical problem of maximum sizes. (Table No. 2.) From these values the range of the different products has been chosen, as indicated in the last two lines of the table. Their scale will be determined by the size of the sheet it is desired to use. Since it is not necessary to have the points of origin lie within the border lines, it is desirable to keep the minimum readings greater than zero when this can be done without impairing the utility of the chart.

The problem illustrated by the arrows in Chart No. 6 is a tank 85 feet in diameter, specific gravity = 1.0, 16,000 pounds fiber stress, 65 per cent. efficiency of joint, and 35 feet head.

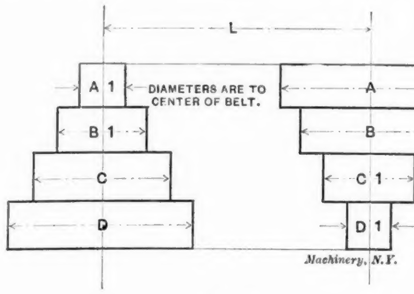


Fig. 3.

The thickness is read to the nearest even fraction on the side of safety as ¾ inch.

Cone Pulleys.

The following chart (No. 7) for cone pulleys illustrates the variable scale principle combined with subtraction and division. For crossed belts the belt will be of uniform tension when $A + A_1 = B + B_1 = C + C_1$, etc., but for open belts the middle steps must be larger in diameter than for crossed belts.

The formula used by the machine tool combine for this case is as follows: (See Fig. 3.)

$$x = \frac{(A - A_1)^2 - (B - B_1)^2}{2\pi L}, \quad x_1 = \frac{(A - A_1)^2 - (C - C_1)^2}{2\pi L},$$

$$x_2 = \frac{(A - A_1)^2 - (D - D_1)^2}{2\pi L}, \text{ etc.}$$

where x = total correction to be added to the sum of $B + B_1$, x_1 = total correction to be added to the sum of $C + C_1$, etc., to preserve a uniform belt tension, the diameters used in the formula being to the center of the belt.

Proceeding to construct a chart which will give the values of x, x_1, x_2, etc., for any case within its range, we first inspect the formula. We have three main values involved $(A\text{-}A_1)^2$, $(B\text{-}B_1)^2$ and $2\pi L$, the difference between the first two being

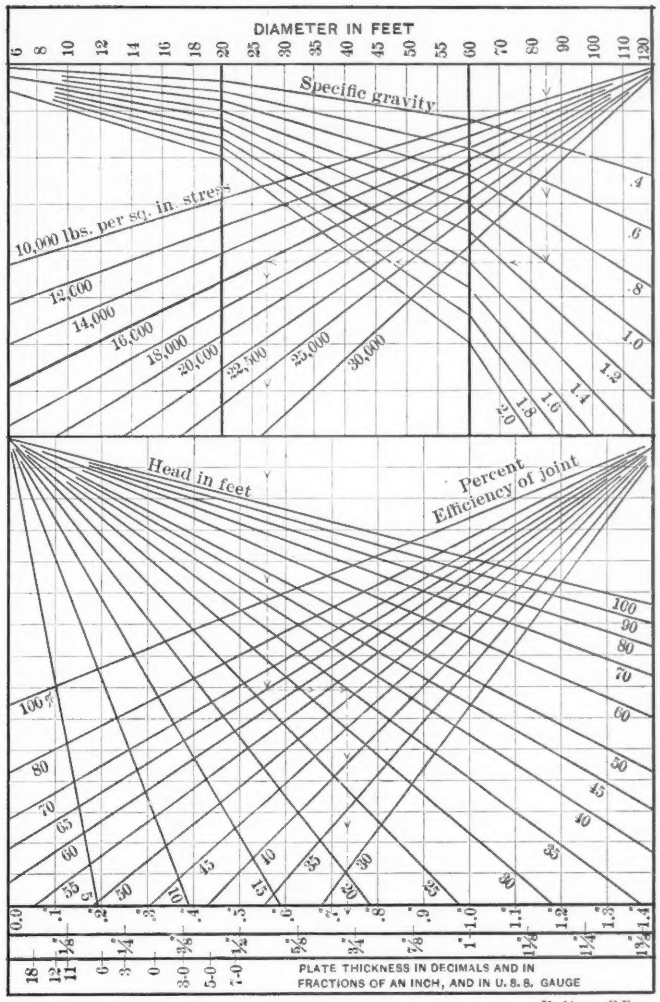


Chart No 6.

divided by the last. As 2π is a constant it does not enter as one of the variable factors. The first two factors are to be squared. This is best accomplished in the following manner: Lay out at the top of the chart in lead pencil a uniform scale, in this case the range has been chosen from 0 to 1,000; this represents the values of $(A\text{-}A_1)^2$; now spot off underneath this scale by the aid of a table the square roots of such numbers as will make a fairly uniform looking scale, inserting their values in ink and erasing the former. In this case we wish to subtract from the first quantity $(A\text{-}A_1)^2$ a similar quantity $(B\text{-}B_1)^2$ Since the range of $(B\text{-}B_1)^2$ should be nearly

TABLE II. TABULATED FACTORS AND PRODUCTS FOR USE IN SELECTING LIMITS OF READINGS AND SCALES.

	First Factor, Diameter in Feet $= D$	Second Factor, Specific Gravity $= G$	First Product $= D\,G$	Third Factor, $1 \div$ stress $= \frac{1}{S}$	Second Product $= \frac{D\,G}{S}$	Fourth Factor, $1 \div$ Efficiency of Joint $= \frac{1}{y}$	Third Product, $= \frac{D\,G}{S\,y}$	Fifth Factor, Head in Feet × Constant $= H \times 2.598$	Fourth Product, Thickness in inches $= 2.598\,\frac{H\,G\,D}{S\,y}$
Assumed values which would give minimum final reading	6	.65	3.9	$\frac{1}{25000}$	.000156	$\frac{1}{.80}$	.000195	10 × 2.598	.005
Assumed values which would give maximum final reading	120	2.0	240	$\frac{1}{8000}$	.03	$\frac{1}{.50}$	.06	100 × 2.598	15.6
Practical problem of maximum size it is desired the chart shall handle	120	1.1	132	$\frac{1}{16000}$	.00825	$\frac{1}{.60}$	.01375	40 × 2.598	1.43
Fixed upon as minimum reading	6	.4	0	$\frac{1}{30000}$	.0002	$\frac{1}{1.0}$	0.0	5 × 2.598	0.0
Fixed upon as maximum reading	120	2.	160	$\frac{1}{10000}$	.0086	$\frac{1}{.30}$	.015	100 × 2.598	1.4

the same as for $(A\text{-}A_1)^2$, lay off on one side of the chart the same uniform scale from 0 to 1,000, starting with 0 at the same corner as on the top scale. Now, parallel lines drawn from one value on the top scale to an equal value on the side scale will represent the values $(B\text{-}B_1)^2$, and perform the operation of subtraction; the lines having the same values as their point of origin on the top scale need not be numbered, and the squaring operation having already been performed by the

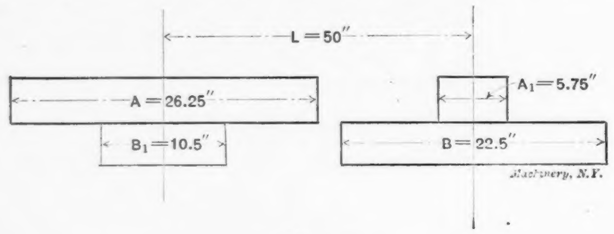


Fig. 4

variable scale designate them $B\text{-}B_1$. The values on the side now represent the result of the first operation and are equal to $(A\text{-}A_1)^2 - (B\text{-}B_1)^2$, which value is to be divided by $2\pi L = 6.283L$.

Now lay off a uniform scale on the bottom for values of x, x_1, x_2, etc., which is the required answer. The range of this scale has been chosen from 0 to 2 inches, as this is probably the limit to which one could trust to the accuracy of the chart, since 2 inches increase in the sum of the diameters would make approximately 6 inches increase in belt length.

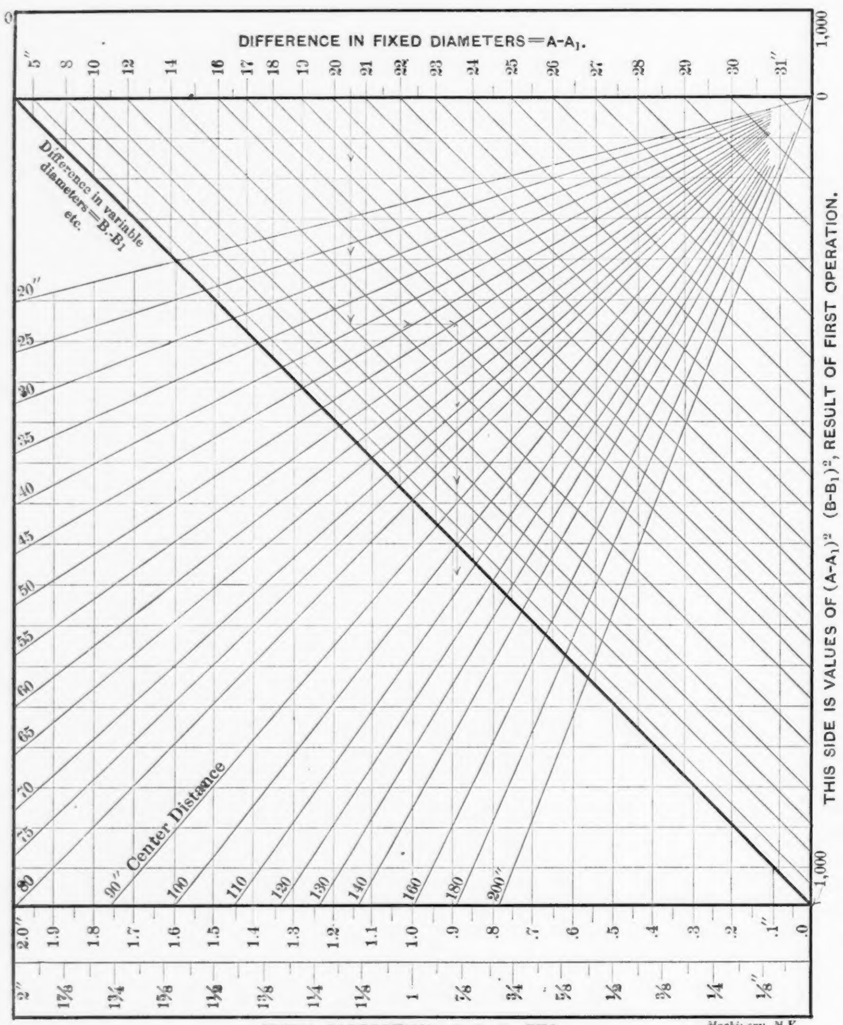


Chart No. 7.

Choosing the intersection of the 1,000 line of top uniform scale with the zero line of the side scale as a point of origin, draw diverging lines to perform the last operation which is one of division. While these lines have a value of $6.283L$, they are designated by the values of L, the constant affecting the final value only.

Example in a pair of cones, Fig. 4:

$A = 26.25$ inches,
$B = 22.5$ inches,
$A_1 = 5.75$ inches,
$B_1 = 10.5$ inches,

as calculated for crossed belts according to the formula $A + A_1 = B + B_1$, the ratio of speed reduction being fixed by other conditions. $L = 50$ inches. $A\text{-}A_1 = 26.25 - 5.75 = 20.5$ inches, $B\text{-}B_1 = 22.5 - 10.5 = 12$ inches; correction

$$x = \frac{20.5^2 - 12^2}{6.283 \times 50} = .879.$$

Solving this same problem by Chart 7, follow as indicated by the arrows; the result is read off at the bottom as .88 inches, which is near enough for all purposes. If the pair of cones are both to be cast from the same pattern, the corrections need only be carried out up to and including the middle step, as the remaining steps are obviously duplicates of the already corrected ones. The formula upon which this chart is based is said to be nearly correct and practically perfect for a leather belt even on a foot lathe.*

* * *

TRACK INSPECTION APPARATUS.

The increase in speed, load and number of trains on the Northern Ry. of France during the past ten years has led the engineers of the system to adopt a more efficient method of track inspection than that previously used, since the stresses upon the permanent way have been considerably increased in spite of the fact that rails have been increased in weight from 60 pounds to 90 pounds to the yard. The principle of the revised method lies in the substitution of an inspection of conditions for the older one.

It is no longer based on observations derived from an examination of the conditions of the track, which may be modified by impressions that are more or less variable according to the position and temperament of the man who makes them, the condition of the cars from which the observations are made, or the mere external appearance of the section submitted to inspections. It is important that each case should be accurately defined, and that this may be done the vertical and horizontal irregularities of the track must be registered.

The author gives some reports on the methods used to inspect the tracks of the Northern Railway in a rapid and methodical manner and of preserving a record of the work done. These observations are made by means of a registering apparatus placed in a special car, which may be hauled at the rear end of any train. Two platforms located at the ends afford every convenience for an inspection of the track, of noting special points and controlling the operation. The irregularities are registered by inertia pendulums of the Sabouret type, whose oscillations are shortened by the addition of springs. The kilometer posts, the changes of grade and other points are noted on the strip of paper which is moved by a suitable mechanism and on which all results are recorded. The conditions, shown by these diagrams, are then communicated to the several section foremen, whose watchfulness is thus always kept on the alert and who will be held responsible for the repairing of such defects as may be pointed out.—*General Review of Railroads*, December, 1903.

* * *

A rule adopted in some mines is to reject a rope when it ceases to stretch. At this point the rope acquires a permanent set and thereafter the behavior of the material becomes irregular and is eminently unsafe.—*Mining Reporter*.

* This formula was developed by John B. Croker, formerly Chief Designer of the Niles Tool Works. He died about two and a half years ago.

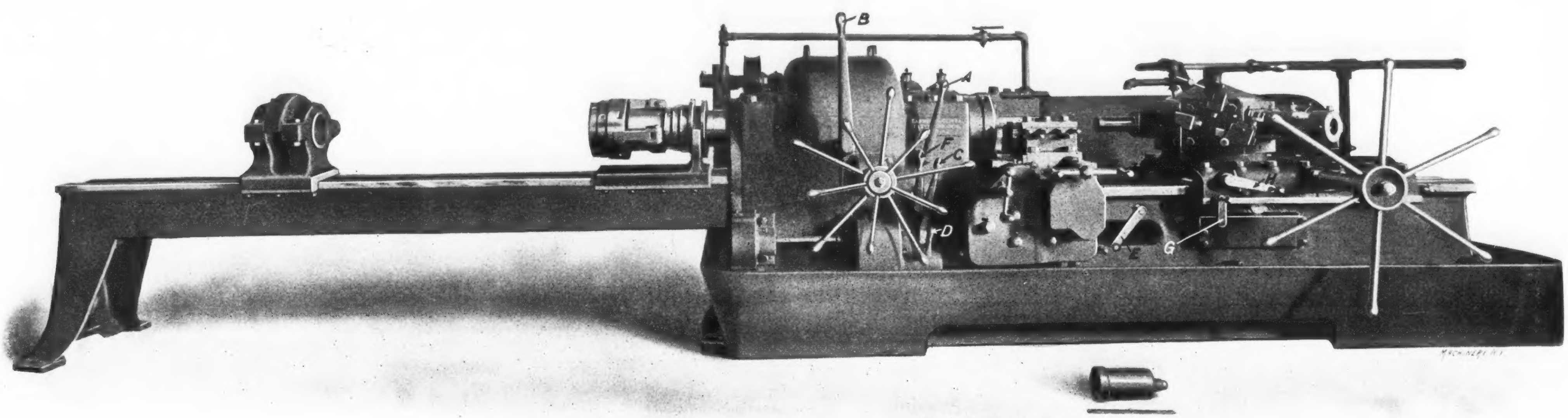


Fig. 1. Heavy Turret Lathe for Operating on Bar Stock up to six inches in diameter. Locomotive Cross-head Pin in Foreground Completed from the Bar in eighteen minutes.

A LARGE BARDONS & OLIVER LATHE.

What is probably the most powerful automatic chuck turret lathe ever built has been shipped by its builders, Bardons & Oliver, Cleveland, O., to the new shops of the Canadian Pacific Railroad Co., Montreal. The lathe is designed for operating on bar stock up to 5 inches in diameter, and is proportioned to meet the exacting requirements of the modern shop where the use of high-speed steel is the rule and not the exception.

Turret machines taking as large as 5-inch round bars have been built before, and are regularly manufactured to-day, but it has been customary on these large machines to use a special type of lathe chuck for gripping the stock. The makers of this machine have adhered to a modified form of the automatic chuck used on screw machines, believing from their experience that no method of holding a bar equals in gripping power the so-called spring chuck or collet, provided it is properly designed and constructed. With this style of chuck the stock is gripped equally around the entire circumference, and the cutting tools can be brought nearer to the spindle bearing than with any other form.

Another departure from the ordinary practice is in the support of the outer end of the bar. There are two usual methods of doing this, one to place a chuck at the rear end of the spindle, which must be opened and closed after each piece is made. The other is to allow the bar to revolve freely in a forked bearing or bushing on the upper end of a light support some distance from the rear end of the head.

In this machine a heavy guide is bolted rigidly to the rear end of the head, and extending far enough to reach the end of a twenty-foot bar when in place in the machine. Sliding on this guide is a carrier, revolving in which is a bushing or chuck, with four screws spaced equally around its circumference. By means of this the outer end of the bar can be made to revolve concentrically with the front end, and almost perfectly round work obtained when using forming tools.

The lathe head is double friction geared, giving four spindle speeds without stopping the machine, and if all three pulleys of the triple friction countershaft, which is regularly furnished with the machine, are used for "go ahead speeds" twelve spindle speeds can be obtained without stopping the machine. The greatest ratio of gearing is about 20 to 1, while the smallest ratio is about 3 to 1. The cone spindle is driven by a 7-inch belt from a triple friction countershaft, with pulleys 24 inches in diameter. The machine can be arranged for motor drive if desired. The construction of the gearing on the cone spindle is of the ordinary back gear type, a sliding wedge which engages the friction through the fingers being operated by the lever *A* on the front side of the head.

The cone spindle is connected with the main spindle through an intermediate shaft carrying a sleeve gear and pinion meshing into the two large gears on the main spindle. These last two gears are loose on the spindle, and either can be clutched to it as desired by means of the lever *B* working through a similar friction mechanism to that used on the cone spindle. Babbitt is used for the main spindle and also the cone spindle bearings. The main spindle bearings are oiled through sight feed lubricators located on the tops of the caps. The front bearing is 8 inches diameter by 13 inches long.

The cone spindle has a hole in the center running almost the entire length, connecting at one end through a stuffing box with a fixed lubricator. Smaller radial holes lead from this central hole to all bearings of the spindle and friction parts, ensuring thorough lubrication, by centrifugal force, from this one source of supply. As this is a fast-running shaft, the necessity of some such arrangement as this can be readily understood. The intermediate gear shaft is lubricated in a similar manner. All gears and rotating parts are fully enclosed.

The combined forming tool slide and cutting-off tool slides constitute one of the most striking features of this machine, and have been designed for the special purpose of producing as much of the work as possible with wide forming tools fed crosswise against the work rather than with end cuts by the turret tools. Experience obtained in the manufacture of

bicycle hubs, projectiles and other irregularly-shaped pieces of circular cross section has demonstrated the superiority of this method wherever practicable. The forming slide, shown in longitudinal section in Fig. 3, is made long and heavy, and carries two massive tool blocks, one at the rear for the roughing tool and one at the front for the finishing tool. Tools to form up to twelve or fourteen inches in length can be held in these holders. The holders are removable and special attachments can be fitted for other classes of work when desired. The forming tools are adjusted vertically by means of taper wedges, which in turn are moved by screws. They are clamped solidly to the holders by bolts passing directly through them. Screws are also provided for the lateral adjustment of the tools. A very little practice enables them to be set quickly and accurately. The forming slide can be fed by hand or power in either direction. The power feed has four changes by means of the lever *C*, and the reverse is obtained by the lever *D*, Fig. 1. The feed has an automatic release in either direction. In practice the roughing tool is usually fed by power and the finishing tool by hand. A graduated dial on the handle enables work to be formed accurately as to size.

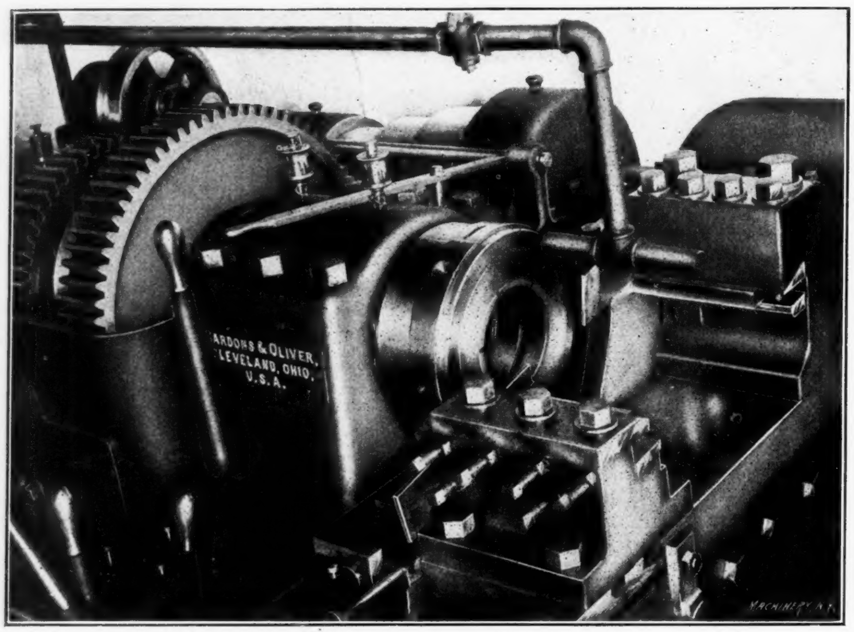


Fig. 2. View of Forming and Cut-off Tool Slides.

The cutting-off tools are two in number, mounted on separate slides, shown in longitudinal section in Fig. 4, which have an entirely independent cross feed from the forming tool slide, although they are carried on the same saddle casting, this saddle having a longitudinal adjustment of 3½ inches by means of the handle *E*. These cutting-off tool slides are fed in simultaneously by a right and left-hand screw either by hand or by power. The power feed is taken from the same shaft as the power feed to the forming slide, but has separate throw out. The front cutting-off tool slide has an adjustment so that the tools can be set to cut equally. The cutting-off blades are made of high-speed steel and are of special cross section. Four changes of feed can be obtained by means of the lever *C*.

The turret and turret slide, Fig. 7, while amply large, are not so heavy that they cannot be readily operated by hand. The most severe duty falls on the forming slide, and with this fact in mind great care has been taken in designing the turret and slide not to make it clumsy and difficult to handle. It travels directly on the bed on flat bearings of ample width. Wipers on the front end of the slide keep these bearings clean. A taper gib runs the entire length of one side, and provides means for taking up side wear.

The turret is hexagon in form, and is 18 inches diameter across the flats. An independent stop is provided for each face of the turret, these stops having a range of 36 inches, while the total feed to the turret slide is 42 inches. Each face of the turret has eight ⅞-inch tapped holes for the purpose of attaching the various tools. There is a 4½-inch hole in each face of the turret and also through the center stud, thus enabling work up to 4¼ inches in diameter and 42 inches long to be turned. This diameter can be increased if desired. Power feed to the turret slide is provided, and four changes to this feed can be instantly obtained by means of the lever *F*, Fig. 1. The power feed can be tripped at any point by each of the independent stops, which also serve as dead stops for the hand feed. The power feed can be thrown in or out by hand by means of the lever *G*. The lock bolt is withdrawn by hand through the lever *H*, and the turret is revolved by hand. Means are provided for locking the lock bolt after it is withdrawn, if desired, so that the turret can be revolved in either direction past one or more holes. The lock bolt is tapered on the upper end and fits into hardened and ground steel bushings in the bottom of the turret. It also slides in hardened and ground bushings in the turret slide.

The turret has a large projection on the bottom fitting into a corresponding opening in the top of the slide. This serves to take the major part of the thrust, but in addition to this a taper bushing is inserted in the center of the turret, taking its bearing on the steel turret stud which extends from the under side of the turret slide to the top of the turret. This bushing is adjustable endwise to take up all wear. The turret stud extends through the large washer on the top of the turret, and is threaded on the outer end to receive the binder handle, by means of which the turret and slide can be clamped solidly together.

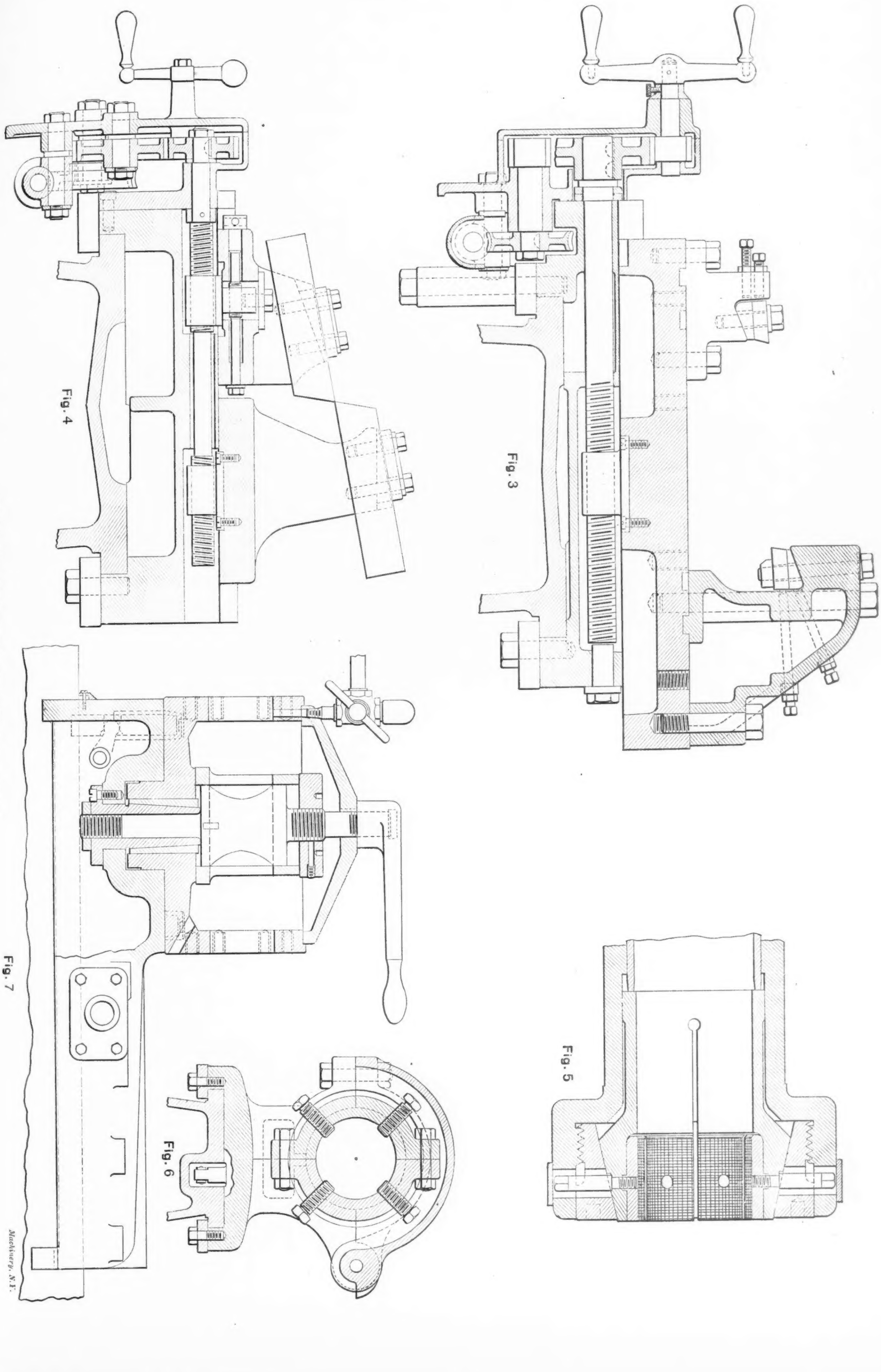
The stock is held at the front end of the spindle by means of a master collet, Fig. 5. The false jaws are easily changed without removing the collet or collet ring from the spindle, as the jaw screws extend through large holes in the spindle to a point nearly flush with the outside. A sliding ring covers these holes when the machine is in use. The false jaws are usually serrated to increase their gripping power. The collet is closed upon the stock by means of the large turnstile on the front of the head which operates the sliding wedge and fingers on the rear end of the spindle.

Variation in the size of the bar is provided for by making this wedge with three steps. The collet is adjusted by means of the adjusting nut at the extreme rear end of the spindle, so that the fingers rest on the middle step of the wedge when gripping stock of the correct diameter. If the stock comes a little small the fingers are run up to the large step of the wedge; if a little large they stop at the small step, so that the bar is always securely held by the collet.

The feed dog or carrier, Fig. 6, as has already been explained, has been designed to serve another purpose besides the mere feeding of the stock. It is in reality a four-jaw independent chuck, by means of which the stock is not only supported at the outer end, but can be made to run concentrically with the spindle at that point, thereby insuring that the finished piece will be round.

The feed dog is moved along its bed by means of the smaller turnstile on the front of the head. The shaft of this turnstile passes through the center of the shaft of the turnstile which operates the mechanism for opening and closing the collet. It has been customary to make one turnstile serve both of these purposes, but with this construction ample power can be had for operating the chuck, while for feeding the stock forward (which requires comparatively little power) a quick motion of indefinite length is obtained. Connection between the smaller turnstile and the feed dog is by means of an endless sprocket chain.

The base of the machine is cast in the form of a pan. This pan has a large reservoir at the back so that there is room for an abundant supply of lubricant without keeping the pan itself filled. A perforated plate over the reservoir keeps the chips from entering, and the lubricant that runs down



Some Details of the New Bardons & Oliver Turret Lathe.

Machinery, N.Y.

the front side of the machine is conducted back to the reservoir quickly through an opening under the center of the bed. There is also an opening in the top of the bed between the turret slide and the forming slide, which allows chips and lubricant to fall directly into the back of the pan.

As an example of the capabilities of this machine, in Fig. 8 is shown a locomotive crosshead wristpin which was made from a 4⅞-inch steel bar stock, in the remarkably short time of eighteen minutes. The first operation after chucking was to turn down the end to 2 inches diameter from *B* to *C*, which took seven minutes with a box tool. This tool is exceedingly strong. The cutter, which is made of high-speed steel, is provided with a releasing mechanism so that the work will not be scored when the tool is moved back. The tool has two back-rests, which are adjustable in and out, so that the work is able to be backed up at the proper place. The cotter pin end was turned by means of a pointing tool held in a tool-holder clamped to the face of the turret. The 2-inch thread was cut by a self-opening die head with roughing and finishing attachment. The section *A* and *B* was turned and shaped by means of large forming tools of high-speed steel. While the piece was being formed the cutting-off tools were started, thereby saving time. Pieces thus turned out are guaranteed to be within .001 inch of round.

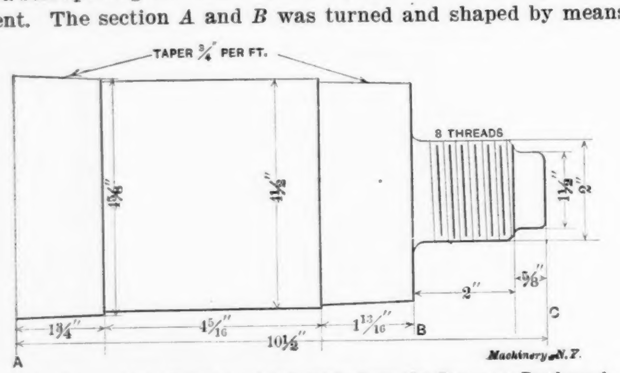


Fig. 8. Locomotive Cross-head pin made from the Bar on a Bardons & Oliver Machine in eighteen minutes.

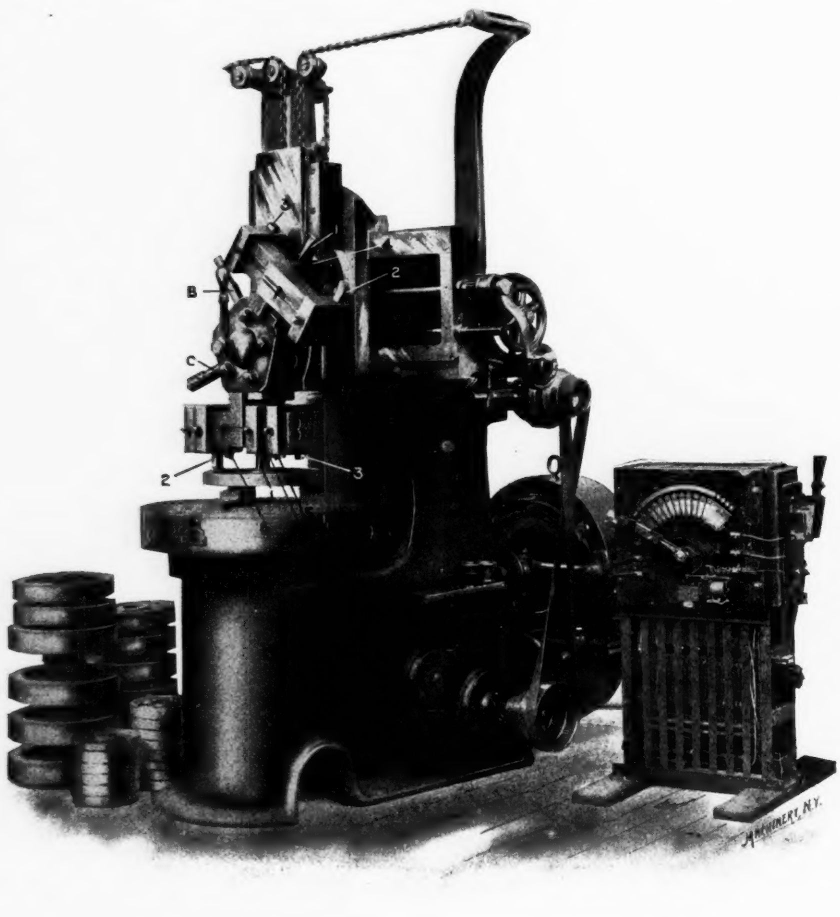
This machine can also be furnished to take bar stock 6 inches in diameter.

METHOD OF FINISHING GEARS AT THE BULLARD MACHINE TOOL COMPANY.

The accompanying illustration of a 30-inch boring and turning mill with turret head, equipped with a full set of adjustable tools for finishing gear blanks ranging in size from 4 inches to 24 inches in diameter with but two settings, will prove of undoubted interest.

The various operations and tool holders therefor are designated alphabetically, and the tools are numbered according to the successive operations performed. The blank is secured by finger jaws gripping inside of rim. It is readily brought to true by the combination chuck in table, and is brought level with the table by the parallel blocks on which it rests.

Tool holder *A*, carrying a four-lip core drill No. 1, outside turning tool No. 2 and facing tools No. 3 and No. 4 for the rim and hub, completely roughs one side of the blank while the hole is being rough bored. Tool *B*—a single-point boring tool—is next run through the bore at a racing cut to insure concentricity, leaving just enough metal to be cleaned up by the special universal joint reamer *C* to finish the bore absolutely true and to size.



Bullard Boring Mill Fitted for Rapid Production of Gear Blanks.

The tool holder *D* is of the same design as *A* but carries a standard size guide plug (No. 1) which, in entering the bore, insures concentricity of diameter, and also adds to the stability of the tool. Tool No. 2 finish-turns the outside diameter of the blank to size and has completed its operation before finish-facing tools No. 3 and No. 4 are brought into action on the rim and hub. The corners of the rim and hub are rounded off by tools No. 5 and No. 6.

In the second setting a stud (the diameter of the bore of blank) is fitted into center of hole in table and a driving stud set in T-slot of chuck jaw. A blank is then dropped over it and tool holder *A*, minus tools No. 1 and No. 2, roughs the faces of rim and hub, which are finished by the corresponding tools in tool holder *D*; the rounds being formed as before.

The method of holding blank from the inner surface of rim insures uniform thickness of the rim when finished, and by the use of the guide plug in finishing tool *D*, the outside diameter is not only turned absolutely true to size but runs on centers within .0005 inch. The tools used in the holders number twelve, and all operations are completed without moving the turret slide from its central position on the rail, thereby saving all time usually required to set tools and caliper for diameters. Most of the tools employed are of the ordinary form and can be used on other boring mill work.

All gears of the above sizes are finished in this way at the shops of the Bullard Machine Tool Co., Bridgeport, Conn., U. S. A., and a saving of from 50 to 75 per cent. is made over the more common method of separate chucking and turning on arbors.

* * *

A hydraulic lift lock was recently completed in the Trent Canal at Peterborough, Ontario, which is a unique piece of engineering on this side of the Atlantic, there being no other example of such work in American canal systems. The Peterborough lift overcomes a difference of level of 65 feet. It consists essentially of two immense steel troughs side by side into which the barges are floated, provision, of course, being made for dropping the end pieces or gates out of the way. These troughs move up and down in vertical guides and one trough counterbalances the other through the hydraulic pistons and cylinders by which they are handled. The rams of the presses are 7½ feet in diameter and have a stroke of 65 feet, working under a gage pressure of 600 pounds per square inch. It is believed that the presses are the largest ever built.

TOOL MAKING.—10.

ARBORS.

E. R. MARKHAM.

Arbors are used to provide a means of holding pieces which have holes passing through them. They may be supported by means of centers, or by portions at the end which fit in recesses of the proper shape and size; or they may have tapered shanks which fit in holes of a corresponding size and taper.

Almost every machine shop is provided with one or more sets of arbors used in providing centers for pieces of work having holes in them and which must be machined after the holes are made. These arbors are slightly tapering in order that work may be tightly forced on them to insure their holding when being machined. This taper also takes care of any *slight* variation that may occur when machining the hole to size. Arbors of this description are generally termed *mandrels*, although in some shops they go by the name of tapered arbors.

Mandrels 1½ inches in diameter and smaller are usually made of a grade of steel that will harden. For those larger than the size mentioned custom varies, some mechanics making them of steel that will harden, while others use machinery steel and caseharden it, claiming it to be sufficiently stiff for the larger sizes. As a consequence they can produce a satisfactory article at less cost than when using tool steel,

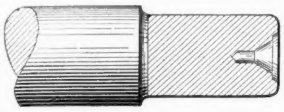


Fig. 1.

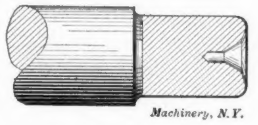


Fig. 2.

or even a low grade of steel having sufficient carbon to cause it to harden when heated to a red and dipped in water. Some mechanics make all large mandrels with the ends hardened, the balance of the mandrel being soft. As local conditions must determine the advisability of using any method, we will consider the operations involved in making them by each method.

When making mandrels from tool steel in the ordinary shop it is the custom, generally, to make them of such grade of tool steel as is in general use in the shop. However, if many mandrels are to be made this becomes a costly method, as a grade of steel can be procured that answers nicely for this class of tool which is much cheaper than steel suitable for the general run of cutting tools. Then again, steel for cutting tools—if efficiency is considered—should be made from a reasonably high-carbon steel; while mandrels are less liable to break or spring when hardened, if made from a steel containing less carbon.

The ends of mandrels are turned to size before hardening. The centers should be deeper than for tools of a corresponding size which are not to run on centers, or which are not to resist as great pressure on the centers when in use. In order that the centers of mandrels may not become mutilated when

Fig. 3.

in use, they should be made as shown in Figs. 1 and 2. The cupping shown removes the outer ends of countersunk portion from liability of mutilation when the mandrel is forced out and in the pieces of work.

The center portion of the mandrel is turned to a size somewhat larger than the finish size, the amount depending on the size of the mandrel and the method employed when hardening. Under ordinary circumstances, however, for mandrels ½ inch in diameter and smaller, an allowance of .015 inch will be found sufficient. For diameters from ½ inch to 1 inch an allowance of .020 to .025 inch; and for arbors over 1 inch, .025 to .030 will be found sufficient. As the length of mandrels larger than 2 inches does not increase relatively to the size, the last amount of allowance will be sufficient for most purposes if proper care is exercised when hardening.

The size of a mandrel should be plainly stamped on the end adjoining the large end of mandrel. This method of stamping should always be observed, as it will save endless confusion.

The corners *b b*, Fig. 3, should be rounded, as shown, to prevent their chipping if the mandrel is driven by means of a hammer. The flat spots *c c* for the dog screw to bear against should be milled or planed. In some shops it is considered

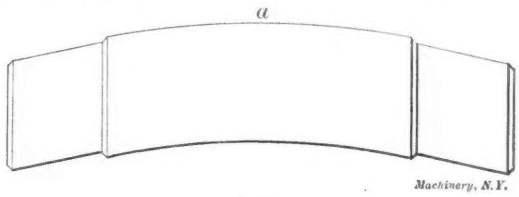


Fig. 4.

advisable to make both of the flats on the same side of mandrel as shown in Fig. 3, while in others they are located on opposite sides. This seems to be a matter of choice, and practice must correspond to the notions in the individual shops.

Before hardening, the centers should be re-countersunk to true them. For this operation a countersink made specially for this purpose should be used, the included angle of whose cutting edges should be 59 degrees instead of 60 degrees, as in the regulation article, as it simplifies the operation of lapping the centers to alignment after hardening. This operation is necessary if we wish a mandrel that will prove satisfactory, as the natural spring of the tool when hardened would throw the centers out of alignment, as shown in Fig. 4. If properly done the operation of lapping will grind these centers so they will bear properly on the centers of the machine.

When hardening extreme care should be exercised in heating, as uneven heating is a more common source of trouble than any other. In order to get uniform heats it is necessary to have a fire adapted to the piece we are to heat. Some furnaces are made which insure uniform heating, while others demand constant attention and considerable skill on the part of the operator to insure satisfactory results. If a blacksmith forge is to be used, have a fire large enough to insure a

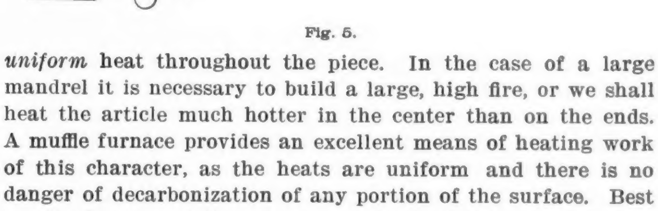


Fig. 5.

uniform heat throughout the piece. In the case of a large mandrel it is necessary to build a large, high fire, or we shall heat the article much hotter in the center than on the ends. A muffle furnace provides an excellent means of heating work of this character, as the heats are uniform and there is no danger of decarbonization of any portion of the surface. Best results, however, follow the use of the method described under "Pack Hardening."

As it is of the utmost importance to have the walls of the centers of the mandrel properly hardened, the operator must assure himself that the contents of the bath have free access to the center holes. This cannot be accomplished if the article is dipped in the bath by means of an ordinary pair of blacksmiths' tongs. In order to accomplish the desired result a pair of the description shown in Fig. 5 should be used.

Where an ordinary bath is used it is considered by many advisable to grasp the mandrel by the large end with the tongs in order that the small end may be the harder; the larger end would be more apt to come in contact with the head center of the lathe when in use and as it revolves with it, it would not be subject to as great an amount of wear.

If many tools of this description are to be hardened it is advisable to "rig up" especially for it, as better results are thus insured. It does not necessarily follow when we prepare in a thorough manner for a certain class of work that we must go to great expense in so doing; many times a comparatively inexpensive equipment answers as well as a more

costly one, and it has the further advantage of not keeping us from making changes when something better is shown us.

By using sufficient care it is possible to heat almost any mandrel of ordinary size and length in almost any fire ordinarily furnished for heating steel; but the use of fires not adapted to the piece are not to be advocated if many pieces are to be heated. It is not, however, advisable to attempt to harden work in a bath that will not give desired results; neither is it necessary as a rule, as baths can be constructed for most purposes at a comparatively small cost.

Now as we wish to harden the entire surface of the mandrel, we shall have best results if we force the contents of the bath against the sides, in order to drive away the steam which forms from the contact of the red-hot metal with the liquid. This steam, if not forced away from the heated metal, forms a cushion around or at portions of the surface, thus keeping the contents of the bath from coming in contact with the steel, causing soft portions or spots.

It is also very desirable that the walls of the center holes be hardened sufficiently to resist wear. To accomplish this we should have a supply of water coming up from the bottom of the bath and another entering it from the top. All this can be accomplished by using a bath of the description shown in Fig. 6, which has several pipes coming up from the bottom. These pipes are perforated to allow the water to be projected against the mandrel. A stream of water coming

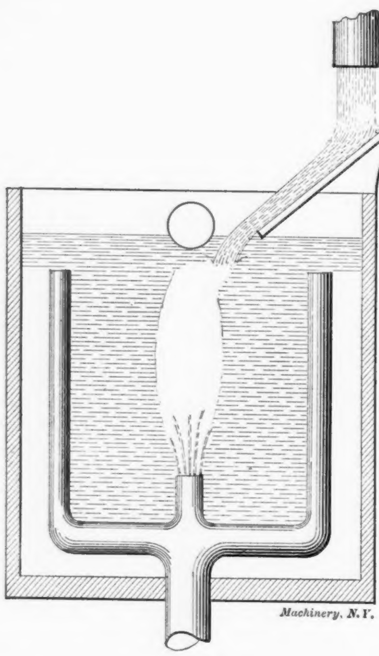


Fig. 6.

up from the bottom strikes the lower end. A pipe may supply a stream at the top of the bath, or water may run onto a board as shown, and running off the board onto the surface of the bath will give a sufficient supply for the upper end. In the absence of such a bath a barrel or tank of water, or brine will answer for small mandrels if these are worked up and down rapidly in the bath. I have hardened a great many articles of this sort in such a bath, but never with such uniform results as when a suitable bath was used. And as such a bath can be made very cheaply by taking an oil, or other suitable barrel, and making the necessary pipe connections, it seems folly to use something not suited to the job, provided, of course, we have a sufficient quantity of work to insure our going to even this slight expense.

As small mandrels would be very apt to break when in use if left as brittle as when taken from the bath, it is necessary to draw the temper of those smaller than ¾-inch diameter to a straw color. In order to do away with liability of chipping the corners of ends of mandrels when driving them in or out of work it is advisable to draw the *ends* of all mandrels to a straw color, leaving the *bodies* of the larger sizes, however, as hard as when taken from the bath. If the ends are softened by tempering, as suggested, the operator must be sure to leave them harder than the centers they are to run on; but as centers are generally drawn to a brown color, the arbor ends, if left at a light straw color, will be enough harder than the centers to insure the centers of the mandrel resisting wear. That is, the lathe centers, being the softer, will wear, which should be the case, as the lathe centers can be easily trued, while if the centers of the mandrel wear the tool is ruined.

After hardening and before grinding, the body of the mandrel should be cleaned of all scale or grease, as this would glaze the emery wheel used for grinding it to size. As long articles if hardened by the methods ordinarily used are liable to be somewhat sprung, they should be tested before grinding to ascertain if they have sprung more than will grind out before they are to size. This can be accomplished by cleaning the scale out the center hole, then trying on centers. If sprung, the smaller sizes may be straightened by the method illustrated in the article on counterbores. In order to straighten larger sizes it will be necessary to heat them as described and straighten them under a screw press or similar device. Generally speaking, however, if due care has been exercised when making and hardening it will not be found necessary to straighten the larger sizes, as they will rarely spring enough to require this operation.

The centers may be lapped to shape and alignment by means of a copper lap of the proper angle (60 deg.) charged with emery. The lap may be held in a drill chuck in the head spindle of a lathe and revolved at a fairly high rate of speed. The opposite end of the mandrel may be supported by the tail center of lathe, and the necessary pressure be applied by means of the tail spindle screw. After the centers are lapped to shape, carefully clean all emery from them by washing in a can of kerosene oil, or in benzine—preferably the latter. If benzine is used care must be exercised that it is not brought near a flame, as it is extremely inflammable.

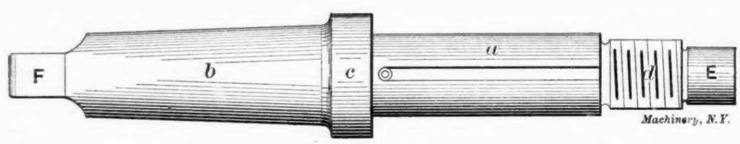


Fig. 7.

In shops where it is used it is kept in a can or dish having a cover which fits tightly. When the cover is removed a rod is passed through a loop in the top which is long enough to allow the cover to be put in place without burning the hands should the benzine catch fire. If it is used at all it should be in small quantities to avoid danger, as far as possible.

As the truth of the mandrel depends in so great a measure on the condition of the centers of the machine it is ground in, they should be carefully examined before using. A mandrel should be ground to size in a universal grinding machine if one is available, as both centers are dead centers; that is, neither of them revolve, the work instead revolving on them. However, if no such machine is available an engine lathe having the necessary grinding attachment may be used.

For work of this character it is best to have a machine which allows the use of water running on the work to keep it cool. In the absence of such facilities, however, it may be ground dry, but the operation is necessarily slower.

If the grinding is to be done on an engine lathe provided with a grinding device we should assure ourselves that the live center is to the proper angle and runs true. Should it *run out* when the mandrel is ground it will cause the piece of work to run out of true on the end adjoining this center. The dead center should be in good condition in order that it may have a good bearing in the centers of the mandrel. The live spindle of the lathe must fit nicely in the boxes, or any irregularities in the belt or the portion where the belt is laced will cause a jump in the spindle which will of course be duplicated on the work being ground. However, if reasonable care is exercised, and the lathe is in good condition, excellent work can be turned out without the latest form of universal grinding machine. In some shops it is the custom to convert the oldest lathe in the equipment into a grinding

lathe and as the work that should be finished by grinding is generally of a character that requires accuracy and truth anything but satisfactory results follow.

The work should be ground to within a few thousandths of an inch of finish size with a coarse wheel, as otherwise it would become heated and spring. Now pieces of steel are very apt to spring somewhat when hardened; it is obvious that when we start grinding it is on the convex side, as shown at *a*, Fig. 4. If we grind with a fine wheel, or one that is glazed we heat the work and this heating is on the convex side; and as the effect of heat is to expand metal it expands or becomes longer on this side, thus springing it still more.

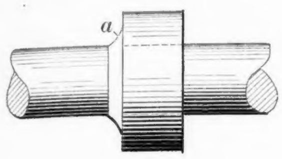


Fig. 8.

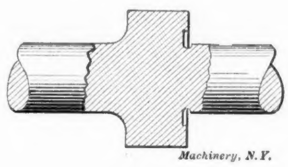


Fig. 9.

Mandrels for ordinary shop equipment are made somewhat tapering. It is generally considered good practice to give them one-half thousandth inch taper to an inch of length, and this seems to give general satisfaction. However, for some purposes it is advisable to give double this amount, or .001 inch to each inch of length, but never unless the pieces that are going on them are comparatively thin, or short. A long piece would get a bearing on only one end and as a consequence the opposite end when machined would be somewhat eccentric to the hole.

Special mandrels made for holding long pieces of work are made nearly, or quite straight, thus insuring a bearing the entire length.

The small end of a mandrel is ground slightly smaller than the size designated—say one-half thousandth inch for ordinary sizes. If larger than 1 inch make it one-thousandth inch smaller.

After grinding to within a few thousandths inch of finish size with a coarse wheel, the work should be finished to size with a fine wheel.

Mandrels with Hardened Ends.

The ends of this form of mandrel are made the same as those previously described. The center is roughed to a size somewhat larger than finish, the amount depending on the size of the mandrel and the method to be used in finishing. If the body is to be ground to size the amount need not be as great as when the mandrel is hardened all over. If, however, it is to be turned to size in the lathe it is necessary to leave considerable more, leaving it, say, 1-32 to 1-16 inch above finish. The ends should, of course, be hardened before

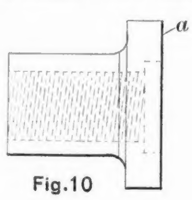


Fig.10

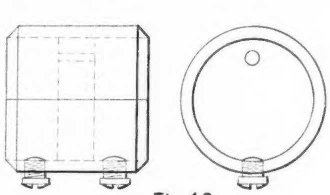


Fig.13

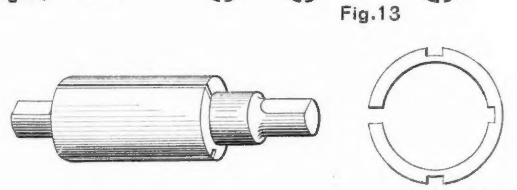


Fig. 16.

the body is finished, which can be accomplished by heating in an open fire or a crucible of red-hot lead, then dipping in a bath having a jet coming up from the bottom. It is necessary, of course, to heat one end and harden it, then proceed with the other end. If the piece is being heated in the open fire it will be found necessary to protect the end first hardened, while the other end is being heated, by covering it with a wet cloth or piece of waste that has been saturated with water. The same instructions given previously for grinding answer when mandrels are made with soft bodies. If the body is to be turned to size look to the condition of spindle bearings and centers.

Making Mandrels of Soft Steel.

When mandrels are made of soft steel, the same general directions given for making of steel that will harden may be followed, up to the operation of hardening. It will be necessary, of course, to caseharden them, which is done by packing in a hardening box, surrounding them with charred bone. The cover should be placed in position and the joints sealed with fire clay mixed with water to the consistency of dough. This is termed luting. After the clay is dry the box may be placed in the furnace and the work subjected to heat for a length of time that will insure its hardening to the required depth.

In order to insure the centers being sufficiently hard it is sometimes considered advisable to sprinkle a little powdered cyanide of potassium in the center holes after the mandrel is taken from the fire, and before dipping in the bath.

The depth of hardening necessary depends in a measure on the nature of the work to be machined on the mandrel and should be deep enough to prevent its being mutilated by carelessness.

Taper Mandrels.

This form of mandrel is made in the same manner as the ordinary form except that the body is of the desired taper. If other means are at hand it is not advisable to turn the taper on this form of tool by setting over the tailstock of the lathe, as this method has a tendency to distort the center holes; a lathe with a taper attachment should be used if

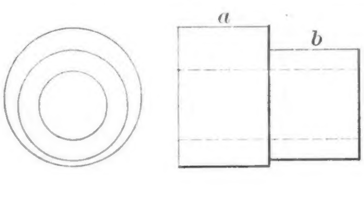


Fig. 11.

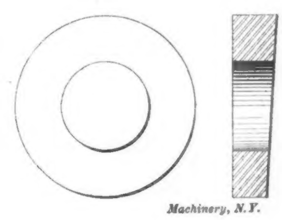


Fig. 14.

possible. If no such attachment is to be had and it is necessary to set over the tailstock, the centers may be carefully recountersunk before hardening.

If possible, grind taper mandrels on a universal grinding machine. If such a machine is not at hand and the lathe must be used by setting over the tailstock, exercise all the care possible to prevent distorting the center holes.

Milling Machine Arbors.

This form of arbor should be made from a stiff steel. As a rule crucible tool steel is used. Where many arbors are to be made it is advisable to use a cheap tool steel, or a machinery steel sufficiently stiff to prevent its springing when subjected to strain incident to arbors of this class. A good grade of open-hearth steel containing 60 to 70 points carbon answers nicely, and the arbor, or portions of it, may be hardened if desired.

Arbors of this class may be forged to shape, being left large enough to machine to size, or they may be turned from stock a trifle larger than the largest part; or they may be made from stock sufficiently large to turn to the size of shank (*b*) Fig. 7, or body (*a*); and the shoulder (*c*) made as a separate piece and shrunk on. If this method is followed it is advisable to leave a portion of the stock somewhat larger than the hole in the piece we are to shrink on, as shown in Fig. 8 at *a*. This prevents the shoulder *c*, Fig. 7, from moving if it is subjected to severe strain when tightening the nut. Another method consists in welding the shoulder *c* onto a piece of steel of the desired size.

After turning in the lathe to dimensions 1-16 inch larger than finish size the ends *E* and *F* should then be turned so that *E* will be .015 large in order that it may be ground to size after hardening, while *F* is brought to size and the tenon milled as shown. After this the centers should be recountersunk and the ends hardened. After hardening, the end *E* should be drawn to a full straw color, and *F* to a deep brown.

The portion d should be turned to size and threaded to receive the nut, which should be made and hardened before this portion is threaded.

If a lathe having a taper attachment is not available, and it is necessary to turn the tapered shank b by setting over the tailstock, it should be turned before the portion a. If a grinding machine is available, a and b should be left .018 to .015 inch large and ground to size. If the portion a is to be ground the arbor should be splined before grinding.

Before splining, a hole should be drilled a trifle deeper than the depth of spline cut, and with a drill a little larger in diameter than the width of the spline slot. This hole is to furnish a place for the tool to stop in when cutting the spline slot. This operation should be done in the shaper or planer.

It was formerly customary to make the slots in arbors and milling machine cutters in the form of a half-circle. When the cutter was placed on the arbor a complete circle, more or less irregular, was formed. A piece of drill rod was used for a key. This method has been superseded in most shops by slots having vertical sides and which receive a square piece of stock to keep the cutters from turning on the arbor.

Fig. 12.

If the portion of arbor marked a, Fig. 7, is ground to size, it is advisable to grind the side of the shoulder next this portion in order that it may be at right angles and perfectly true with this portion, which may be accomplished very nicely if the side is made as shown in sectional view, Fig. 9.

It is customary to make nuts for arbors of machinery steel, which are casehardened when completed. They are made by placing the blank in a lathe chuck, drilling, boring and threading to the desired size. If a tap of the proper diameter and pitch is at hand the thread may be cut with an internal threading tool nearly to the proper depth, then finished with the tap. If a tap is not available it may be threaded to size with the threading tool. The outer end should be faced, and the threads at the end turned out for a distance of 1/8 to 1/4 inch. It may then be placed on a nut mandrel and finished. After the sides to receive the wrench have been milled the nut may be hardened. After hardening it is advisable to square the end a, Fig. 10, by grinding, in order to correct any irregularities caused by hardening. When grinding it is necessary to screw the nut onto a nut mandrel which runs perfectly true.

Eccentric Mandrels.

When it is necessary to machine a piece of work similar in form to that shown in Fig. 11, or any piece having a portion which is eccentric to the hole, it is necessary to have an arbor

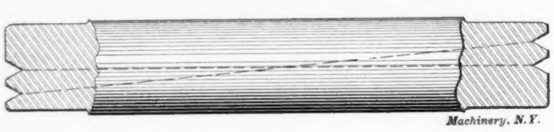


Fig. 15.

which has a pair of centers in its ends located in the proper position to give the desired amount of eccentricity. If the piece is of the form shown in Fig. 11, then the portion marked b may be turned with mandrel running on the regular centers, and the portion a with it running on those which are eccentric to the outer surface. Fig. 12 shows a mandrel of this type.

When making this style of mandrel the instructions given for making the common form of mandrels should be observed, except that with the exception of large mandrels it will not be found advisable to cup the ends around the centers, or at least but very little.

There are several methods employed when locating the eccentric pair of centers, the method used depending on the accuracy necessary to observe when machining the work. If extreme accuracy is not essential the mandrel may be placed, before hardening, between the centers of a lathe. Having previously set a surface gage needle at the height of the point of the lathe centers, now draw a line on each end of the mandrel from the center to the circumference. The needle may be raised the proper amount to produce the desired eccentricity. The mandrel may be turned one-quarter revolution to bring the lines scribed on ends in a vertical position at the top of mandrel. Then lines may be scribed which will intersect the vertical lines at the desired distance from the center. Prick punch the ends where the lines intersect, after which the eccentric centers may be drilled and countersunk. If care is exercised when doing these various operations the result will be near enough exact for most work.

The same result may be accomplished if the mandrel is held in a V-block on a bench plate and the centers laid off by means of a surface gage. In this case, however, it will be necessary to caliper the ends, set the surface gage needle to the height of the top of end, then lower a distance equal to one-half the diameter of end.

If the eccentric centers must be of an exact distance from the center of mandrel and just alike, it will be advisable to make a jig of the form shown in Fig. 13. In order that the jig may do accurate work it will be necessary to turn the ends of mandrel so they exactly fit in the jig. A line must be drawn on the jig, as shown, then a line must be scribed the entire length of mandrel, or at least on each end, to set the jig by, in order to insure exact alignment of the eccentric centers.

It is sometimes necessary to face pieces of work as shown in Fig. 14, the one side to be at right angles to the hole, the opposite side to be at an angle as shown. This may be accomplished by making a mandrel having its eccentric centers on opposite sides of the center holes, as shown in Fig. 15. Either style of mandrel, Fig. 12 or Fig. 15, may, after hardening, be ground to size on the concentric centers.

When there is a slight variation in the size of holes in pieces to be machined on mandrels, a form known as an expansion mandrel is many times used. Not only will any slight variation be taken care of, but the mandrel bears the entire length of the hole in the piece as the bearing points of the mandrel expand on parallel lines. There are several styles of this form in use. That in Fig. 16 gives excellent satisfaction and is easily made. The mandrel proper is made sufficiently tapering to give the desired amount of expansion. It is hardened and ground to size, the sleeves are made with holes of a taper corresponding to the taper of mandrel and they are then split as shown. After the burrs are removed from the hole the shell is placed on the mandrel and ground straight and to the desired size. If a taper expansion mandrel is wanted the outside of sleeve may be given the desired taper. A valuable feature of the expansion mandrel is that it expands into the hole in a piece of work instead of being pressed through it. However, when it is desirable to maintain accuracy as to concentricity expansion mandrels are seldom used.

* * *

Ammonal is a new high-power explosive adopted for the bursting charges of shells by the Austrian Government. Like thermit one of its principal ingredients is powdered aluminum. The other principal ingredient is nitrate of ammonia, hence the name. Unlike guncotton, dynamite, lyddite, melinite and other high-power explosives that have been tried with little or no success for the bursting charges of shells, ammonal cannot be exploded by shock, but, like common black powder, it must be fired with a fuse. For this reason it is likely to become considerably used in the arts of both war and peace. It is the invention of Herr Hans Van Dahmen and is manufactured in the explosive works of Mayr & Roth, Felixdorf, Austria.

* * *

A recent consular report refers to a new application in Australia of the principle of the coin-in-the-slot machine, stating that if a stamp cannot be purchased conveniently it will be possible in the future to drop a letter into one orifice of a postal box and a penny into a second orifice, and the words "one penny paid" will be found impressed on the envelope when the box is opened by the postoffice authorities, thereby securing the transmission of the letter.

SOME ENGLISH LATHES.

JAMES VOSE.

In small, and even fairly large, shops the question arises: "How may we best obtain as great a proportion as possible of the benefits of a modern special turret lathe without sacrificing the 'all-round' handiness and capacity of the ordinary

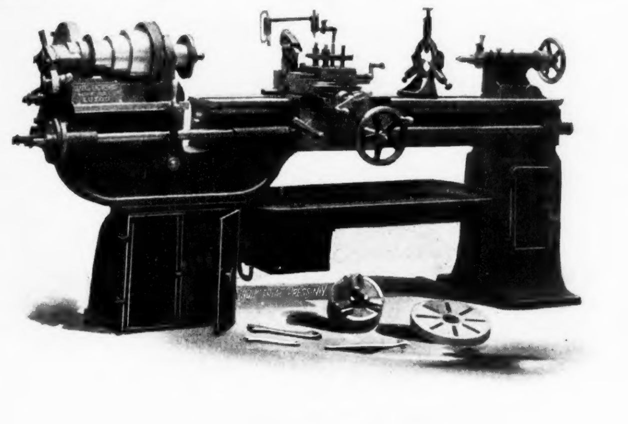


Fig. 1. Type of English Gap Lathe.

screw-cutting lathe?" Moderate cost is, in this connection, generally a matter of moment. The illustrations and particulars herewith indicate how one English concern—Clark's Engineering Co., Ltd., Luton—have endeavored to fulfill these conditions. Readers will form their own conclusions as to how far these efforts are successful from the sketch and time given for the job in Fig. 4. Before describing the tools more nearly answering the description of turret lathes, the 6-inch lathe, Fig. 1 (swinging 12 inches over bed) is a recent example of what in English phraseology is generally described as a "self-acting, sliding, surfacing, and screw-cutting lathe, with gap bed." It will be noted that, with a view to obviating the theoretical disadvantages of the gap bed—the springing of the bed out of alignment—the makers place the left hand leg, which acts as a change-wheel cupboard, underneath the gap—a plan first adopted, I believe, by Mr. Geo. Richards. The

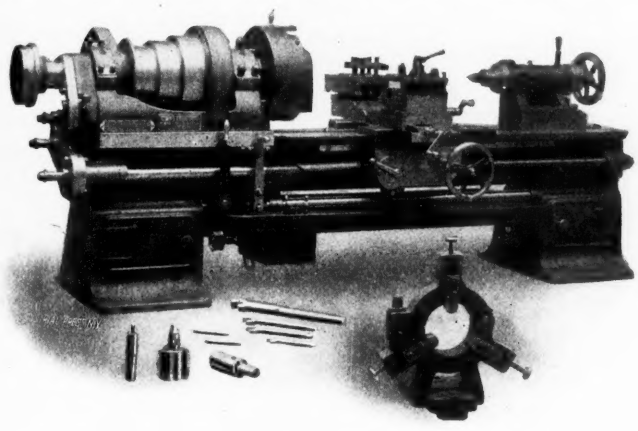


Fig. 3. Eighteen-inch Hollow Spindle Lathe for Operating on Bars four inches Diameter or less.

gap enables a job 24 x 7½ inches to be swung for boring, etc. Each step of the cone pulley is 2½ inches wide, and the diameter of poppet spindle is 1⅝ inch. Three changes of feed are instantly available for sliding and surfacing. The characteristically British four-stud slide rest has a base almost the full length of the slide. On the transverse feed screw is the notched dial wheel of a "quick withdraw" motion, used when screw cutting, for drawing away the tool on the return traverse, and bringing it to its previous position ready for the next cut. The cut-away tailstock, popularized by American makers when they first endeavored to cater to British requirements, is arranged with transverse slide for taper turning, etc. The hinged steadyrest is also designed on American lines. The position of the traveling rest may be moved in the direction of the length of the bed, a facility well worth having. The lathe is fitted with a hollow spindle to take a 2-inch bar. The sud pump and chips pan are an optional portion of the outfit. As in other lathes by this company, the center holes are Morse taper. When the lathe is built to take a job 3 feet long between the centers its weight is 2,264 pounds.

In the hollow spindle capstan lathe, Fig. 2, which swings 16 inches and deals with 3-inch bars, the saddle is arranged to slide past the chuck, when desired, as in some of the more recent American heavy turret lathes. The automatically revolving turret is arranged with six stops. As in the lathe Fig. 3, the headstock bearings are parted diagonally, which would appear to tend toward steady running. The pump, sud fixtures, and splash trap allow of a wide range of brass and steel work to be dealt with in the general shop. The universal chucks generally fitted on these lathes are made by Chas. Taylor, Birmingham. When on a 6-foot bed the weight of this tool is about 2,400 pounds. In the 18-inch swing lathe, Fig. 3, the hollow spindle takes a 4-inch bar, with bed 9 feet long takes 4 feet 2 inches between the centers, and weighs over

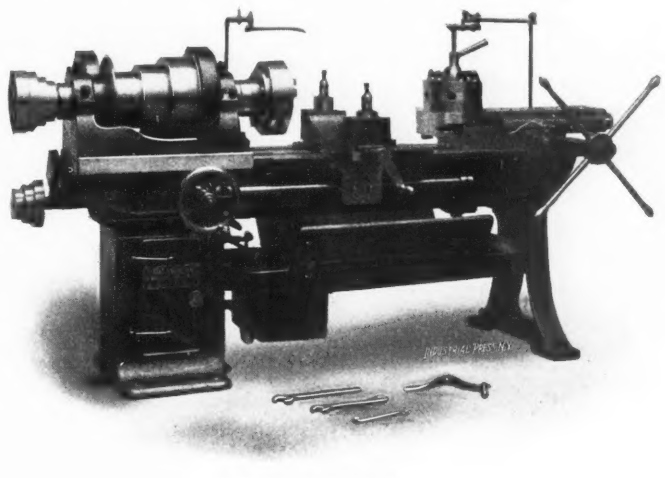


Fig. 2. Turret Lathe.

6,000 pounds. The usual three quick change feeds are available, and the sliding saddle is controlled by six longitudinal stops. The width of steps on the belt cone is 4 inches and the ratio of back gear is 11 to 1. Self-centering chucks are fitted at both ends of the spindle. The loose poppet-head is secured to the bed by two 1-inch bolts and a plate the full length of head. The diameter of the spindle in loose head is 3¼ inches.

The accompanying dimensioned sketch of a job produced complete from a 6½ square steel bar will give a better idea of the metal-removing capacity of the tool than any lengthy description. It will be noted how the outer end of the poppet spindle is notched to suit the projections on the drill socket, thus preventing scoring of the center hole when boring work. A 14-inch swing by 7 feet 8 inch bed by 3-inch bore hollow spindle lathe, built on the same lines as the above weighs 3,700 pounds, and takes 3 feet 8 inches between centers. The width of belt cones is 3½ inches, the ratio of back gears is 10 to 1 and the diameter of loose poppet spindle is 2 inches. The saddle is fitted in front with a 4-tool square turret and depth

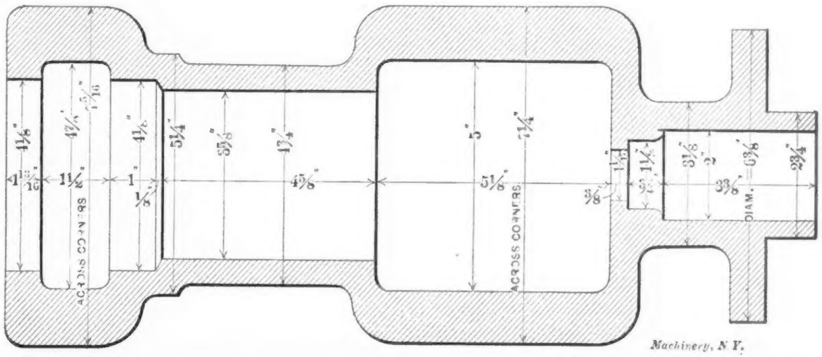


Fig. 4. Example of Work Produced Complete from six and one-half inch Square Steel Bar.

stops and at the rear with a cut-off and forming slide arranged also if desired to carry a die head of the Jones & Lamson or Geometric type. These features as well as an automatic feed to the poppet spindle, worked by gearing from the back spline shaft are applied to both the 14 and 18-inch swing lathes. It is claimed that these lathes are easily capable of utilizing the peculiar features of the latest high-speed tool steels, the cutting tools giving way before checking the speed of the lathes. In conclusion it may be mentioned that the

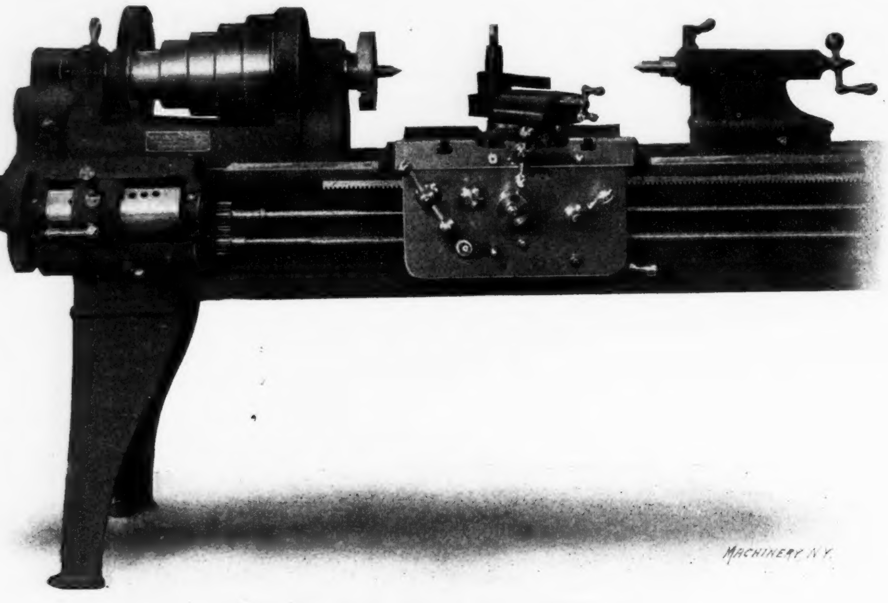


Fig. 1. Sixteen-inch Le Blond Lathe.

subject of quick removal of metal is exciting great interest in Great Britain, scarcely a week passing without a discussion taking place on the topic, or a new lathe for the purpose being placed on the market.

* * *

LE BLOND LATHE WITH QUICK CHANGE GEAR DEVICE.

A new quick-change gear lathe has been placed on the market by the R. K. Le Blond Machine Tool Co., Cincinnati, O. The lathe is fitted with a feed box containing a nest of gears for transmitting motion to the feed rod and leadscrew. These details as well as the gear connection between the feed box and the lathe spindle are shown in the accompanying engravings. The lathe, with the exception of these features, is the same as the standard engine lathe built by this company, and the headstock end is shown in Fig. 1, which gives a good idea of the exterior appearance of the change gear device.

The line drawing, Fig. 2, shows the connection between the feed box and the lathe spindle. The spindle gear *A* drives gear *D* on the stud D_1 through tumbler gears *B* and *C*. The tumbler gears are of the regular construction used for reversing the motion of the carriage in screw cutting, so as to cut either right or left-hand threads, as required.

Motion is transmitted from the tumbler gears through gears *D*, E_1, *G* and *H*, which latter is on the driving shaft of the feed box. In order, however, to obtain a second series of feeds there is a telescopic slip gear located on the stud D_1 which can be made to mesh with gear *G* in place of pinion E_1 which is shown in mesh with gear *G* in the engraving. To accomplish this *G* rotates on a pin in a quadrant *G*, which by means of the clamping handle G_4 and the stops G_2 and G_3, can be brought into the correct position for gear *G* to mesh either with pinion E_1 or gear *F*, as required. The hub of gear *F* is recessed so that it can be slid over pinion E_1, thus bringing this gear in the same plane with gear *G*. Gears *D* and *F* and the pinion E_1 all rotate with the stud, which is journaled in a bearing in the headstock casting. The introduction of the telescopic gear *F* makes a change in the feed ratio of 4 to 1.

Fig. 4 is reproduced from the patent specification and shows clearly the mechanism of the feed box. *A* is the driving shaft and *B* the driven shaft, which in this case is represented as being one end of the leadscrew, but in the actual lathe is connected with the latter by suitable intermediate gearing. However, the principle of the feed changes is the same in either case. Shaft *B* carries a cone of gears and shaft *A* an elongated spur gear *C*, which is the driving gear of the mechanism. Surrounding *C* is a cylindrical barrel *D*, which serves the double purpose of a casing for this gear and a bearing for a sliding bushing *E*, by means of which the adjustment of feed is effected. This bushing carries at *F* an intermediate gear which at all times is in mesh with gear *C* and can also be brought into mesh with any one of the gears in the cone by giving the bushing *E* a combined sliding and rotary motion on the barrel *D*. The portion of the barrel *D* which is toward the cone of gears is provided with a longitudinal slot, to allow the intermediate gear *F* to project through and mesh with gear *C*. The front portion of the barrel is provided with a series of holes, corresponding in number and position to the gears of the cone, so that the bushing which carries the intermediate gear *F* can be locked in its proper position for each gear by means of a spring pin, after the usual manner. The bushing which acts as carrier for the gear, and the barrel which encases the elongated gear, are clearly represented in the general view of the mechanism, Fig. 3.

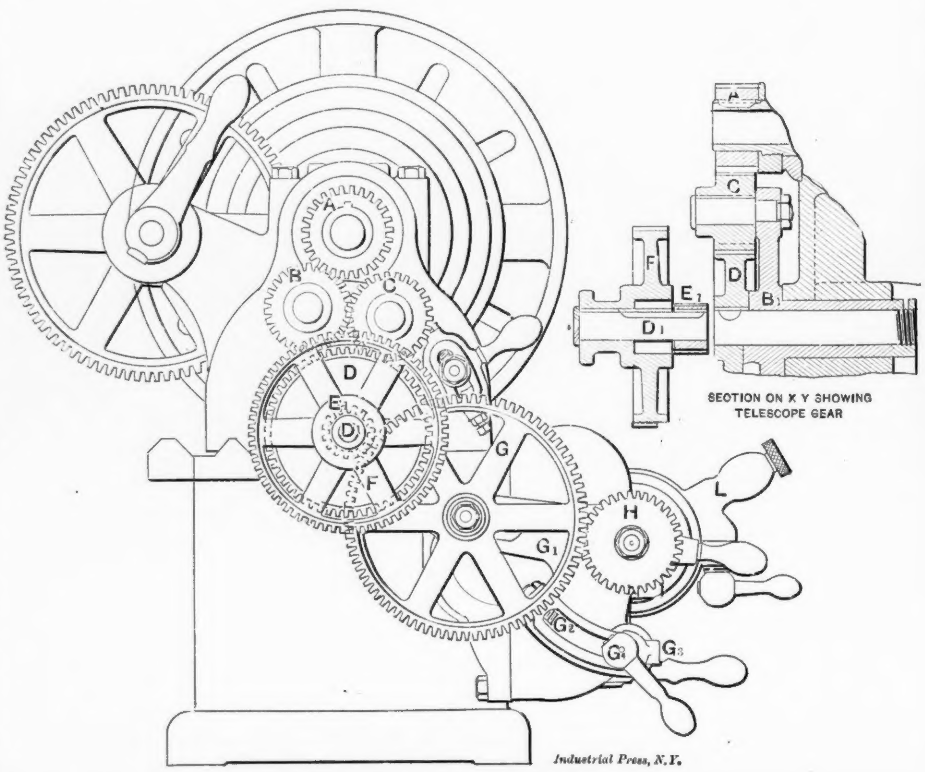


Fig. 2. Details of Gear Connection with Feed Box.

Fig. 5 is a view looking at the rear of the mechanism and its casing, and shows the modifications that have been made in the device to adapt it to the engine lathe. The cone shaft carries besides the eight gears of the cone an additional gear, *K*, and below this shaft, which is marked *B*, is the shaft *L*, which is connected directly to the feed rod, *R*, and carries a sliding sleeve, *S*, on which are two pinions, *M* and *N*. In

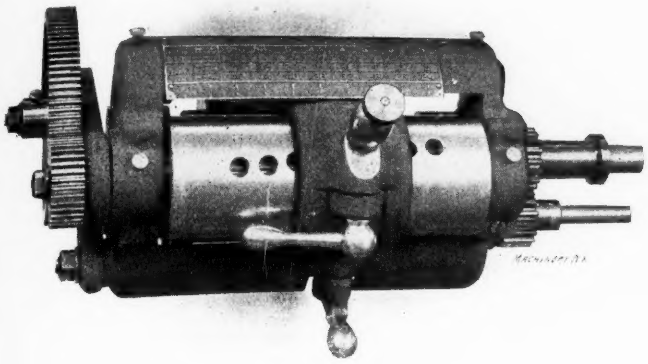


Fig. 3. Feed Box containing Gear Cone.

the position shown in this view power is transmitted from the cone shaft *B* to the gear *N* by means of the auxiliary pinion *K*, and as the sleeve *S* is splined to shaft *L* the motion is transmitted to this shaft and thence to the feed rod. By sliding the sleeve to the right, gear *N* no longer meshes with pinion *K*, but instead pinion *M* meshes with one of the gears of the cone, causing the feed rod to rotate at a faster speed. The leadscrew *T* is driven from the feed rod by a slip gear, *W*, in the usual manner.

In the general view, Fig. 3, the quadrant and the pinion on the shaft with the elongated driving gear appear at the left, while the upper shaft at the right is the leadscrew and the lower one, the feed rod. The slip gear, by which an additional set of speeds is obtained for the feed rod and leadscrew is operated by the handle on the bottom of the engraving.

From the above description it will be seen that with the gear box itself, eight changes of feed are obtained. The slip gear on the auxiliary shaft in the feed box makes 16 changes, and these 16 changes are again doubled by the telescopic gear on stud D_1, in Fig. 2, making 32 changes and giving a range of threads from 3 to 46 per inch, covering every standard thread, including 11½.

This entire range of threads can be made without stopping the lathe or removing a single gear. The feeds are four times the number of threads per inch. It will be noticed that the compounding generally adopted on this style of lathe is done away with, and that wherever there are coarse feeds or heavy threads the increase comes directly from the 4 to 1 gear on the stud D_1 speeding up the feed mechanism of the feed box in the same proportion, so that it is placed under no additional strain.

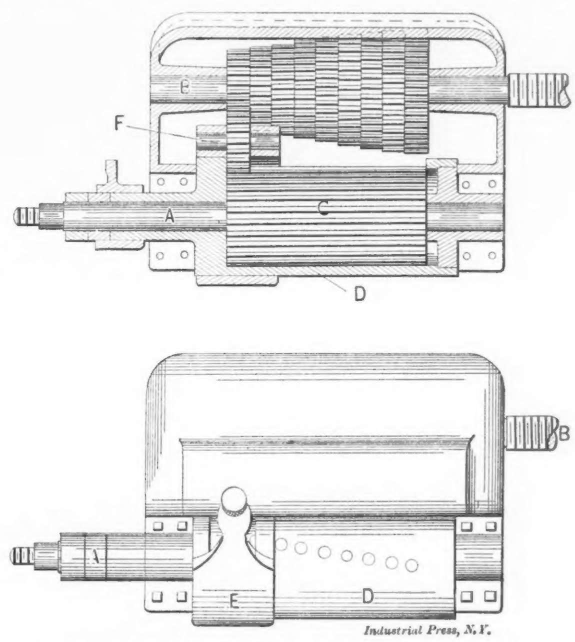


Fig. 4. Reproduction of Patent Drawings of Details.

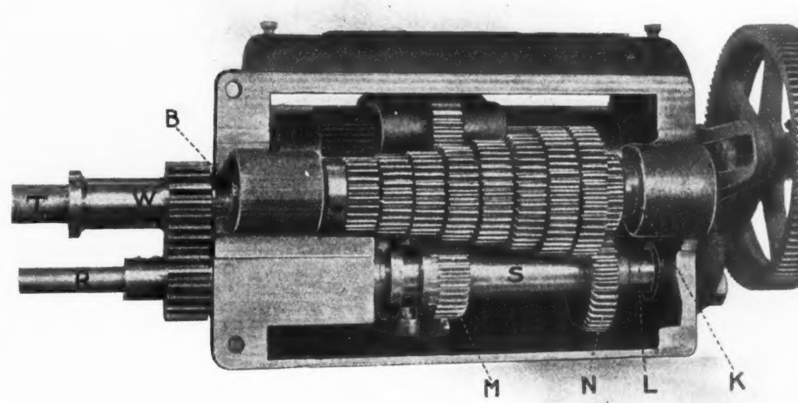


Fig. 5. Rear and Interior View.

* * *

THE IRON THAT GAVE US LEADERSHIP.

The economic results of the discovery and development of the Mesabi range of ore form one of the most important industrial facts in the past half century, says F. N. Stacy in the *World's Work* for September. Since the first shipment from the Mesabi in 1892, the iron ore production of the United States has increased from 16,000,000 to 35,000,000 tons per annum; the pig iron product from 9,000,000 tons to 18,000,000; the steel output from a little more than 4,000,000 tons to 15,000,000; while the iron and steel exports of the United States have grown from about $25,000,000 a year to $120,000,000. During these dozen years, we have become the greatest iron and steel producing country. The Mesabi was the greatest single factor in this achievement, and, without the vast resources of the Mesabi, the present dominance of the United States in iron and steel would have been delayed perhaps for decades. A sixth of the annual iron-ore product of the world—which is more than a third of the yearly production of America—comes from an iron range that was unknown in 1890. The Mesabi range on Lake Superior yields ore enough to make as much iron and steel as all Great Britain makes; and her industrial dominancy was founded on iron. During the fifty years ending December 31, 1903, the Marquette range on Lake Superior yielded more ore than any other mines; but the Mesabi range has produced almost as much in twelve years as the Marquette produced in fifty. In the use of steel, the cheap and abundant ores of the Mesabi have produced a revolution. They have enabled the railroads, within the past six years, to relay, with heavy steel rails, almost the whole rail mileage of the United States. Steel cars, steel ties, steel bridges, steel warehouses, steel ships, steel construction for a thousand purposes for which wood and stone were used before, have followed. Exports of agricultural implements have multiplied five times in ten years. The tonnage on the Great Lakes has doubled. Finally, the iron tide from this vast iron deposit flowing into the channels of industry at the following rate of progression—4,245 tons in 1892, 1,793,052 in 1894, 2,882,079 in 1896, 4,613,766 in 1898, 7,809,535 in 1900, and 13,342,840 tons in 1902—was one of the most powerful factors in the industrial and commercial revival of the United States after the panic and depression that began in 1893; and the impetus it gave our material progress continues to be world-wide.

Entered at the Post-Office in New York City as Second-class Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66-70 WEST BROADWAY, NEW YORK CITY.

LESTER G. FRENCH. Editor.
FRED E. ROGERS, Associate Editor.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

SEPTEMBER, 1904.

NET CIRCULATION FOR AUGUST, 1904,- 22,705 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad. RAILWAY MACHINERY, $2 00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

MACHINERY is ten years old this month.

* * *

THE TREND IN STEAM TURBINE CONSTRUCTION.

Steam turbines may be divided into two classes, comprising those of the reaction type, like the Parsons turbine, and those of the impulse type like the De Laval, the Curtis, Rateau and Zoelly. In a reaction turbine part of the expansion of the steam occurs while the steam is flowing through the passages of the rotating wheels. The steam thus acquires additional velocity while it is passing through these wheels, so that as it leaves the vanes there is a reaction which gives a rotary motion to the wheel. No purely reactional wheels have been successful; they always combine the impulse principle with the reaction principle. In a turbine like the Parsons, for example, the steam acts the same as in an impulse turbine when it strikes the rotating vanes, and when it leaves the vanes it acts upon the reaction principle.

In impulse wheels there have been two principal methods used for reducing the rotative velocity of the wheels. In the Curtis turbine steam impinges against the blades of the first wheel, which latter turns at a lower speed than called for by the velocity of the steam. The energy of the steam, therefore, is not entirely utilized, and it leaves this wheel with a high residual velocity, part of which is again absorbed by a second wheel. The steam in turn acts upon a third wheel, and so on. This is the construction used in the earlier types of Curtis turbine, in which there were two sets of four wheels, each set being inclosed in a separate chamber.

In the Rateau and Zoelly turbines there is a succession of chambers with only one rotative wheel in each chamber. Each of these wheels acts like a single De Laval wheel, there being rows of nozzles which direct the jets of steam against its blades. Inasmuch as there are several chambers, however, the drop in pressure between the succeeding ones is comparatively small, so that the velocity of steam is much less than where the total expansion occurs all at once.

In a paper presented before the Chicago meeting of the American Society of Mechanical Engineers Prof. Rateau, of Paris, was inclined to "rub it into" the manufacturers of the Curtis turbine, by contending that they would finally give up their method of construction and adopt the Rateau turbine. Whether this will finally come about we, of course, cannot say, but the trend is in that direction. When steam is given a high initial velocity by flowing through an expanding nozzle and this velocity is absorbed by a series of wheels in succession, there is a great deal of dissipated energy due to the fact that the jet of steam breaks up and does not flow through the wheels in a solid stream. It seems to diffuse, to a greater or less extent, and much of the energy is lost by eddy currents and friction.

Two recent patents taken out by the General Electric Company are significant, in view of Prof. Rateau's remarks. One is upon a turbine in which the number of rotating wheels in each compartment is reduced to two; the other is upon a turbine in which there is only one rotating wheel in a compartment, just as in the Rateau and Zoelly types. Of course the latter patent is essentially a construction patent, since the principle is not new. It looks very much as though turbine construction were resolving itself into three standard types of machines: First, the De Laval type, in which speed reduction is secured by gearing; second, the Parsons or compound reaction type, and third, the Rateau or compound impulse type having but one rotating wheel in each compartment.

* * *

NOT AS RICH AS WE SEEM.

What sort of nabobs are Americans considered to be? Occasionally we are approached in this office by some foreign gentleman who has come to this country to dispose of "valuable patents" and who expects us to tell him what wires to pull and incidentally accept a liberal commission in case a sale is effected. Unfortunately for us, we have not yet been able to participate in profits of this description. It is somewhat out of our line.

Not long ago a representative wished to dispose of a patent on a type of milling cutter. The price was, as we remember it, $25,000, with 10 per cent. in it for us. He probably had a clear patent, so far as any investigation of records could show; but who doubts that many tool makers may have devised and used similar cutters in commercial work and who would pay a high price for a patent in the face of such a probability?

Another instance is the case of a refrigerating machine for domestic and hotel use. We saw an item about it, investigated in the hope of securing something interesting for our readers, and found incidentally that the American rights were for sale at the modest price of $400,000. In our opinion the patents do not introduce any new principle, but are merely construction patents, and combine old ideas in a new form.

Again, we have been visited by a promoter from abroad who controls a patent on a machine shop operation that has heretofore been performed by hand. He has a machine which does the work automatically by power and thus applies a new principle to accomplish a specific purpose. His patent, however, contains no broad claim. It tells in detail what elements enter into the machine and each claim mentions the several elements. There was evidently a chance for a broad claim, stating merely the principle and its application; but it was not made, and as the patent stands there are a dozen ways to get around it. Yet with this imperfect patent the promoter expected to get $350,000 for the invention. He has been advised to consult a patent lawyer before attempting to collect the cash, however. Should it be possible to take out another patent on the device, covering its basic principle, which we question, it will probably be a salable invention; but we doubt its bringing over one-tenth of $350,000.

It is in view of such instances as these that we ask, What sort of nabobs are Americans considered to be?

* * *

One of the interesting exhibits in the Palace of Electricity at the St. Louis Purchase Exposition is a small transformer of 20 kilowatts capacity, working at an electrical pressure of 500,000 volts. With this enormous voltage the discharge between the terminals occurs through the maximum distance of 32 inches. While the machine is of a very spectacular nature and one well calculated to attract the curiosity of the ordinary sightseer, it is also of great interest to the electrical profession, giving, as it does, ocular proof that the limits of high-pressure power transmission lie not in the power station, but rather with the line outside.

A peculiarity of many photographs of automobiles running at very high speed, is that the wheels are apparently distorted to an elliptical shape with the top inclined forward. As such a distortion is obviously a mechanical impossibility it is interesting to know the cause for the change from the true shape in the photograph. The explanation of the phenomenon, it appears, is that most cameras used for taking high-speed pictures, use the focal plane shutter, a device consisting essentially of a curtain immediately over the plate which contains a narrow horizontal slit. As this slit travels downward over the plate the exposure is made progressively and not simultaneously. Hence, owing to the inversion of the image due to the lens, the lower portions of the wheels are exposed first and by the time the slit has traversed the plate so that the image of the upper parts of the wheels is impressed thereon, they have traveled perceptibly forward. This in connection with the angular view gives the peculiar inclined elliptical shape.

* * *

PROPOSED REVISION OF THE PATENT LAWS.

It is a matter of common knowledge that small unimportant improvements generally pay greater returns to their inventors than the great epoch-making inventions that work a revolution in any industry. One reason for it is that by the time the tide has turned so as to fill the inventor's pockets his patents have expired and the public may use his invention without royalty. A case in point is the Parsons steam turbine, the first patents on which expired last year. The world at large is just awakening to the possibilities in the steam turbine and its advantages over the reciprocating piston system; hence the not unnatural bitterness of the inventor over what he considers to be an unjust feature of the patent laws of Great Britain and other countries. In a recent address delivered by Mr. Parsons before the Engineering Section of the British Association he strongly advocated changes in the patent laws of all countries, especially in regard to the time limit. He pointed out that the development of any great scheme centering on a valuable patent, would be impossible if this development required a period equal to or in excess of the present life of patents. Capital could not be induced to invest in what must necessarily prove a losing game. As a solution of the problem Mr. Parsons suggested the formation of an international committee composed of members from all the countries having patent laws, and that this committee should have control of the life privileges of all patents. The inference is that inventors who have been unable to bring their inventions into general recognition and have not reaped a satisfactory reward, should at the pleasure of the international committee be given an extension of their patents as a reward of genius and to stimulate the development of inventions that require a long period of exploitation.

The full text of Mr. Parsons' address is not at hand so that criticism of his scheme must be based upon the more or less uncertain newspaper report, but the general idea, it seems to us, is unpractical if not dangerous. When we remember the abuses and shady transactions growing out of re-issues and extensions of patents in this country, now happily discontinued, we are in no hurry to give an international committee the power of extending privileges of enormous value for the whole civilized world. Such a committee, no matter how conscientious and upright its members, could not help being moved by the persuasion and arguments which great interests would bring to bear upon them. In general if a company which has developed an invention to a commercial state during the life of its patent, has not acquired momentum sufficient to enable it to compete with all comers, something must be wrong in its business methods, and it savors too much of paternalism to ask a government to put a premium on business incompetency. With the development of large corporations, also, has come the possibility of perfecting and marketing an invention in a much shorter time than when this had to be accomplished entirely by individuals or small concerns. This is not inferring, however, that there are not individual cases where an extension of patent privileges would be no more than justice, but patent laws must be made for general conditions and not for specific cases.

THE MINNESOTA.

Announcement is made of the completion of the *Minnesota*, one of the two sister ships built by the Eastern Shipbuilding Co., New London, Conn., for the Great Northern Steamship Co., Mr. James J. Hill's line across the Pacific. The other ship, the *Dakota*, is still under construction. The Eastern Shipbuilding Co. was organized and the plant equipped for the purpose of building these two ships, which are the largest American-built vessels yet constructed. The *Manchuria*, built at Newport News for the Pacific trade, had heretofore been the largest American vessel, but the *Minnesota* exceeds her in displacement by about 6,500 tons. When fully laden with cargo and stores the displacement of the *Minnesota* reaches 33,000 tons. Other dimensions are: Length over all, about 630 feet; breadth, extreme, 73½ feet, and depth from the bottom of the keel to the upper navigating bridge, 88 feet 3¾ inches—the height of an ordinary ten-story building. As a matter of course the vessel is of massive construction to withstand the enormous strains to which its hull will be subjected. The stern post alone weight 55 tons.

The passenger accommodations are commodious and planned to make the fifteen-day trip across the Pacific a voyage of pleasure. First-cabin passengers have accommodations in a large deck house amidships. Practically all state rooms have outside windows and many of them are arranged en suite, with bath rooms attached. There are the usual library, boudoir, smoking room, etc., and the children have been provided for by an attractively-furnished nursery or play room. The total accommodations are for 218 first and 68 third cabin passengers, while below deck provision is made for carrying thirteen hundred troops or twenty-four hundred steerage passengers. Large and well-equipped toilet and wash rooms are provided for the steerage, also separate galley and pantry.

Four large evaporators for changing salt water to fresh are located in the engine room, furnishing abundance of fresh water to the boilers and for the passengers, should the fresh water carried in tanks give out. These evaporators have a combined capacity of about thirty thousand gallons of fresh water per day. The electric lighting plant is very extensive, as electricity is used for not only lighting all parts of the vessel, but for heating the state rooms, running numerous ventilating fans and supplying power to steer the vessel and operate the cargo hoisting machines.

The ship is driven by twin-screw triple-expansion engines of about 10,000 horse power furnished with steam at 250 pounds pressure by water-tube boilers of the Niclausse type. Each engine is located in a separate water-tight compartment, and the boilers are also divided into two similar compartments, accessible one to the other through small water-tight doors.

The anchors each weigh 8½ tons, and the anchor chain, which weighs over 80 tons, is the heaviest ever built. The full equipment of life-saving appliances as prescribed by the United States government is carried on board, and for putting out flames a patent fire-extinguishing system is installed, by means of which any compartment of the ship may be immediately filled with a gas in which a fire cannot possibly burn. For handling the cargo in and out of the numerous hatches thirty-two electric winches are placed on the deck, for while the *Minnesota* is to be classed as a passenger ship, she is intended primarily to carry enormous cargoes of freight across the Pacific.

* * *

THE DATA SHEET FOR SEPTEMBER.

The data sheet for this number deals with the proportioning of the arms, hubs, faces, etc., of gear wheels, such as are used particularly in mill work and heavy machine construction. This sheet is one of several that have been contributed by W. O. Renkin, Valley Park, Mo. For several years Mr. Renkin was in charge of the toothed gear work at the Union Foundry and Machine Co., Pittsburg, Pa. He has traveled extensively, selling and designing gears for all kinds of service, and has accumulated much tabular matter on the subject, which is now given for the benefit of our readers.

VARIABLE SPEED MOTORS.—6.

THE C. & C. ELECTRIC COMPANY'S SERIES PARALLEL SYSTEM.

WILLIAM BAXTER, JR.

This system was designed specially for the operation of large printing presses, and is not recommended for use in connection with small machine tools. It has been applied very successfully for driving large grinding and polishing machinery and is specially applicable to all cases where a strong starting torque with quick and even acceleration is required and with such a degree of speed variation, at the higher velocities, as can be obtained by field regulation.

The system is used in connection with a compound wound motor that is provided with two distinct armature windings, each one being connected with an independent commutator. In starting, the two armature windings are connected in series, by properly connecting the commutator brushes, and the velocity is gradually increased by cutting out the starting resistance in the armature circuit, and after this the series field coils, these being cut out in two or more steps so as to properly graduate the acceleration of velocity. To increase the speed beyond this point the two armature windings are connected in parallel, and an amount of resistance is cut into the armature circuit that is sufficient to prevent violent acceleration. This resistance is then cut out gradually and the full running speed is attained. To increase the speed beyond this point resistance is cut into the shunt field circuit until the velocity is increased fifty per cent. or more, as may be required.

From the foregoing it will be seen that in starting, a very strong torque is obtained with a comparatively small current, from the fact that both the armature windings are connected in series, and for the same reason the velocity is very low. The two armature windings are alike, so that when they are connected in series, the velocity is one-half as great as when they are connected in parallel. By means of the armature resistance, and the series field coils many different speeds can be obtained between the starting velocity and that obtained when the armature windings are connected in parallel; but, as has been explained in previous articles, variations produced by means of resistance in the armature circuit cannot be used with satisfactory results except in cases where the load is constant, or nearly so. Speeds obtained above the series parallel velocity can be used whether the load is variable or not as they are produced by introducing resistance in the shunt field circuit.

The Controller for the Series Parallel System.

The controller used with this system is illustrated diagrammatically in Fig. 1. It consists of two electro-magnetic switches that are actuated by the movement of a hand-operated controller, and this latter also affects the necessary circuit combinations to cut resistance in and out of the armature and the field circuits. The magnetic switches are for the purpose of making the changes in the connections that are required to change the armature windings from series to parallel. Fig. 2 is an elevation that shows the relative position of the motor and the controller when applied to a large printing press. Figs. 3 and 4 show in detail the main controller. Fig. 5 is a more complete detail of the front of the controller, showing the various contacts. Figs. 6 and 7 show the front and back of the magnetic switches, with the various details of construction. Figs. 8 and 9 are photographic views of one of these switches. Fig. 10 is a photographic view of the front of the main controller.

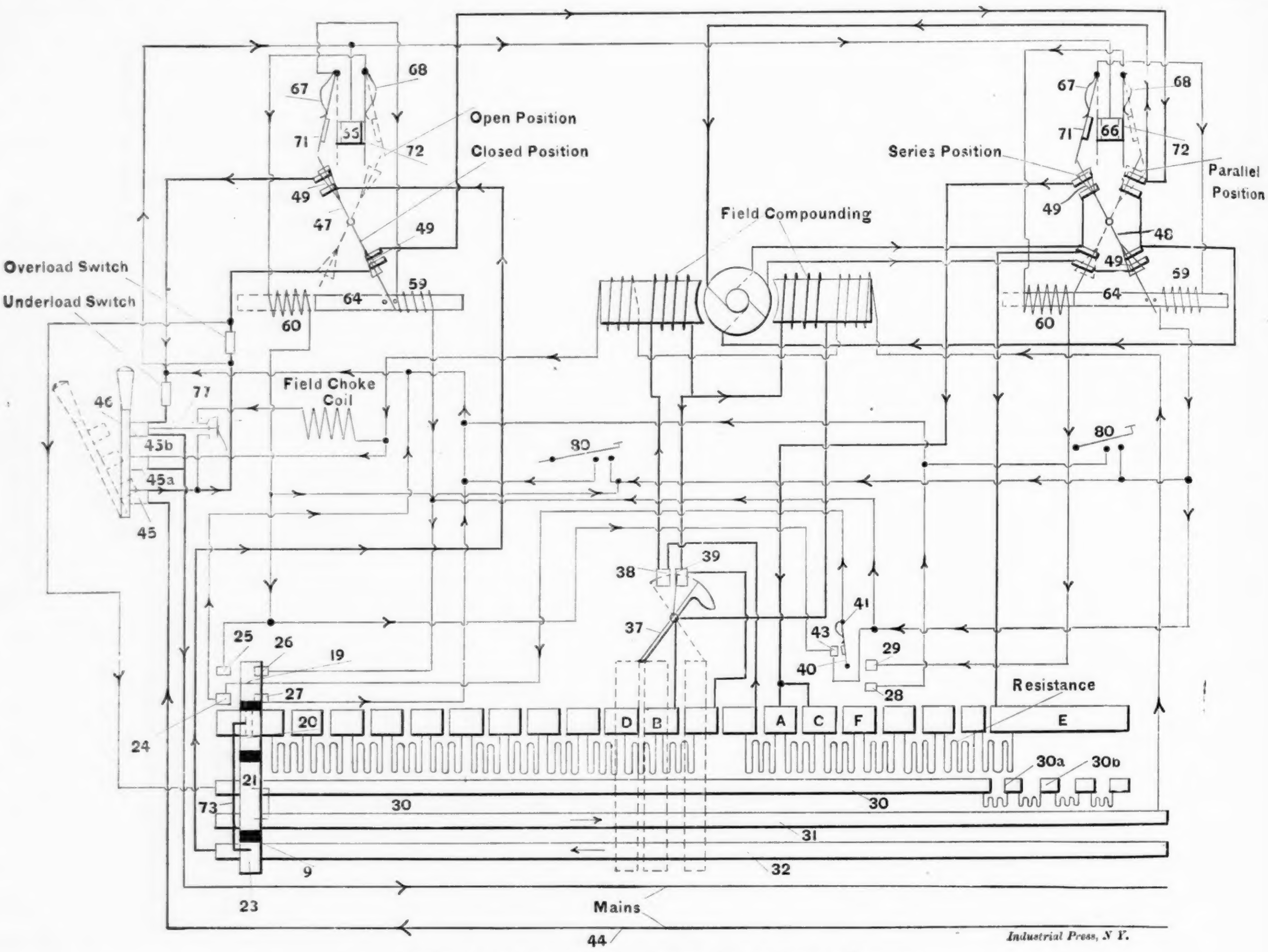


Fig. 1. Controller for Series Parallel System, C. & C Electric Company.

Referring to Fig. 2, 1 represents the frame of a printing press, 2 is the floor line, 3 is the motor, 4 is the gearing through which the motor drives the press, 8 is the main controller which is provided with a number of contacts disposed in circular form, as shown in Fig. 5, over which swings the lever 9. This lever is rotated by means of a segment 11, which meshes into a gear mounted upon the shaft 10 around which 9 rotates. The segment 11 is actuated by the connecting rod 16 attached to the slotted end 15 of the hand lever 12, the latter

being mounted to swing around the stud 13. The position of the magnetic switches is shown at 47, and at *SB* is located a switchboard.

The Main Controller.

The main controller is shown clearly in Figs. 3, 4 and 5. The lever 9 carries contacts 19, 20, 21 and 23. Contact 19 connects with the stationary contacts 24, 25, 26, 27, 28 and 29 (See Fig. 5). Contact 20 connects with the circular row of contacts 8. Contact 21 connects with stationary contact strips 30 and 31, and contact 23 connects with stationary strip 32. A second lever 34 is secured to shaft 10 and is provided with a pin 36 that engages with the forked end of a small switch 37 which swings over and connects contacts 38 and 39. Lever 9 in rotating forward strikes a pin 40 mounted upon a switch 41 that is spring-supported and pushes the same to the right. On the backward movement 9 strikes this pin again and moves contact 41 over contact 43, for a purpose that will be hereafter explained. Contacts 20 and 23 are connected by the cable 73.

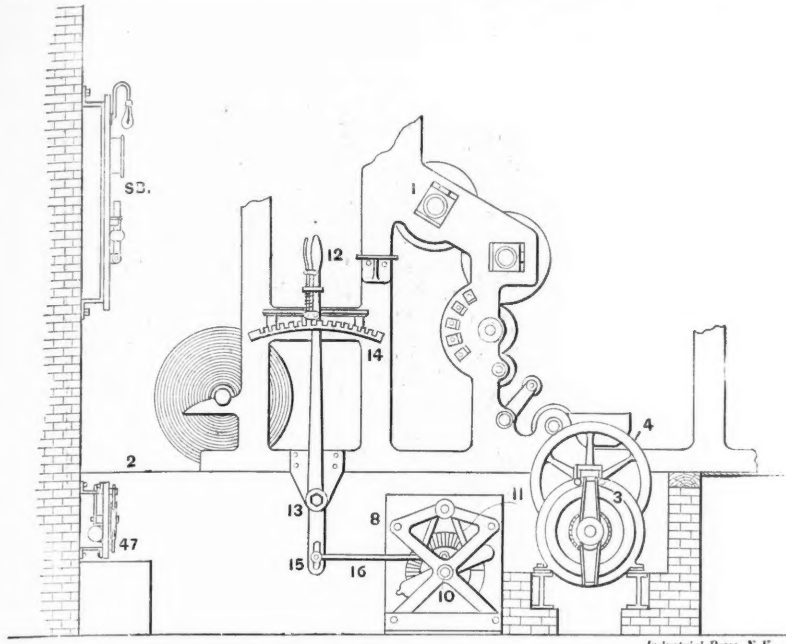


Fig. 2. Elevation showing Relative Position of Motor and Controller.

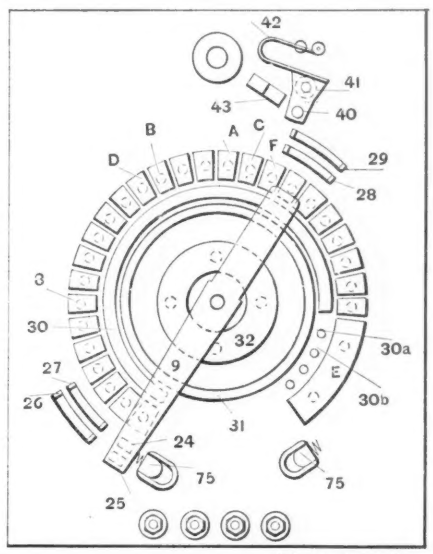
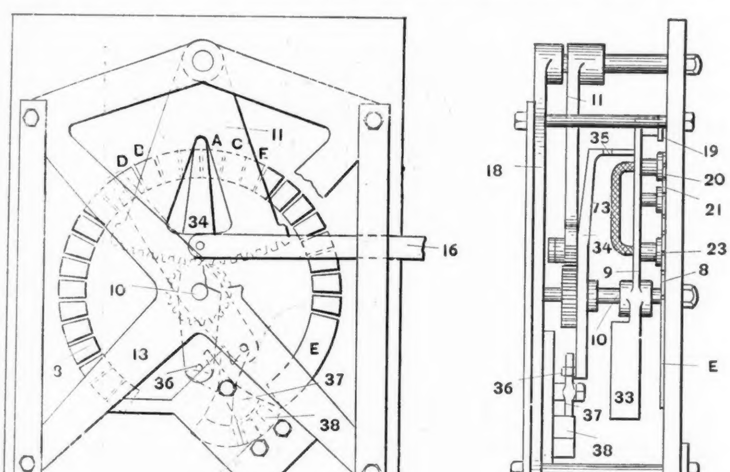


Fig. 5. Detail of Front of Controller.



Figs. 3 and 4. Details of Main Controller.

The Electro-magnetic Switches.

In Fig. 7 the switch lever 47 and 48 is actuated by the solenoids 59 and 60 shown in Fig. 6. The blades 49 are insulated from the lever. The solenoids shown in Fig. 6 are mounted on one side of a slate slab, and the switch lever 47 and the stationary contacts with which it engages are mounted on the other, the shaft 61 passing through the slab. On the solenoid side of the slab the shaft 61 carries a lever 62 provided with a pin 63 at one end, that passes into a slot in the core 64 of the magnets. To throw the switch lever 47 more power is required at the beginning of the movement than at the end, owing to the fact that the friction of the blades 49 against the stationary contacts has to be overcome. To increase the initial pull of the magnets, auxiliary cores are provided as shown in Fig. 6, and these are made movable. In addition a slot 65 is made in the main core, so that when it moves it strikes a blow against the pin 63 and thus dislodges the blades 49 from the stationary contacts. The auxiliary cores, being movable, are knocked out of the way by the main core, hence a long movement of the latter core is obtained with a comparatively short distance, or air gap, between it and the auxiliary cores; the result being that the strength of the magnet is greatly increased during the first part of its movement. The momentum of lever 47 and the other moving parts is sufficient to carry it over into engagement with the opposite set of stationary contacts, after the solenoid magnet gives it the initial movement, and on that account means are provided to automatically open the circuit of the solenoid soon after the switch lever has moved. The stationary contact 66, Fig. 6, and the switches 67 and 68 are for this purpose, and the manner in which they are actuated by lever 62 can be clearly understood. The solenoid magnets are energized when lever 9, Fig. 5, bridges either one of the pairs of contacts, 26, 27 or 28, 29.

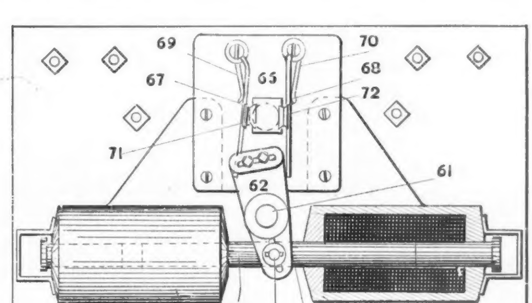


Fig. 6. Diagram showing Rear of Magnetic Switch.

Operation of the Series Parallel Controller.

From the foregoing explanations of the construction of the several switches the operation of the controller as illustrated in diagram Fig. 1 can be readily understood. To make this diagram as clear as possible the controller, Fig. 5, has been represented at the bottom of the diagram with the stationary

contacts rolled out into straight strips, and lever 9 is shown as a bar in the vertical position, at the left of the diagram. In addition, all the parts in Fig. 1 have been numbered the same as in the other illustrations.

The current enters through the mains 44, passes to switch 45, and thence through an overload switch to one terminal of the shunt field and to magnet switch 47, which is shown in the closed position by full lines and in the open position by dotted lines. When lever 9 is moved from the position shown in Fig. 5 to that of Fig. 1, block 19 bridges contacts 26, 27 and a circuit is closed through the arm then in contact with 66, down through solenoid 59 to contact 26 and thus to the main line.

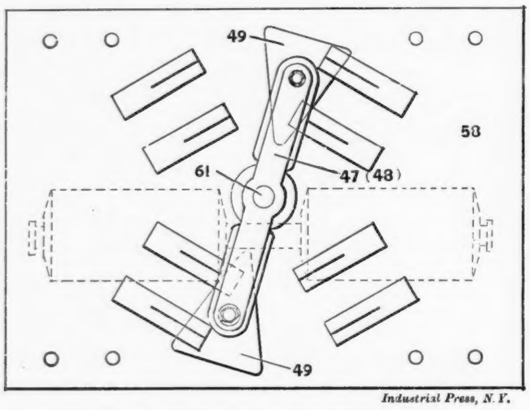


Fig. 7. Front View of Magnetic Switch.

Solenoid 59 being energized will throw 47 to the closed position shown in full lines. The current will then pass through blade 49, lower end of 47 to upper right side of 48 and thence through one armature winding to lower right side contact of 48 and thence through the other armature winding back to 48 and on to contact *A* of main controller. From this point it passes through a resistance coil to the contact at the left and thence through the series field coils to contact *B* from where it passes back to main 44 through lever 9 and switch blade 46. It will be noticed from the connections through the solenoid 59 of switch 48, that if the lever should happen to be in the parallel position it will be thrown over to the series position.

As lever 9 advances it cuts out the armature resistance, until it reaches contact *D* when it strikes lever 37 and cuts out one-half of the series field coils, by connecting *B* with 39. The further movement of 9 connects 38 and 39 with *B*, thus cutting

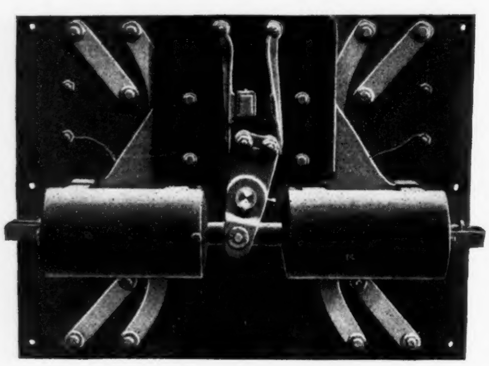


Fig. 8. Half-tone View of Fig. 6.

out all the series field. Advancing further, lever 9 connects contacts 28 and 29 and thus closes the circuit through solenoid 60 of switch 48, thereby drawing the core to the left and throwing the switch into the position shown in dotted lines. This change connects the armature windings in parallel, the armature circuit passing to the end contact *E* thus cutting into this circuit the resistances interposed between *E* and *F*. The further advance of lever 9 cuts out this resistance and finally cuts into the shunt field circuit the resistances interposed between the contacts 30a, 30b, etc.

In moving lever 9 back to the starting position it first cuts out the shunt field resistance, then cuts in the armature resistance and when it reaches pin 40 it carries contact 41 over onto 43, thereby closing the circuit through solenoid 59 of switch 48, thus opening the armature circuit and at the same time connecting the armature windings in series. Moving further to the left lever 9 will strike switch 37 and throw it off the contacts 38, 39. When 9 reaches the starting position, shown in full lines at the left, it will close the circuit through solenoid 59 of switch 47 and thus again close the armature circuit with the windings in series.

From the foregoing explanation of the action of the controller, on the return motion, it will be seen that if it is desired to stop the motor, lever 9 is returned quickly to the starting position; if it is desired to reduce the speed to a point not slower than is obtained with the armature windings in the parallel connection, the lever is moved back slowly to this

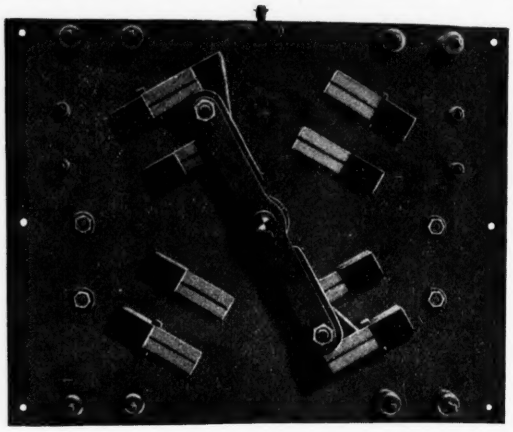


Fig. 9. Half-tone View of Fig. 7.

point; but if a still slower speed is desired, the lever is moved back to the starting position and is at once advanced until it meets the speed to which the motor has slowed down. If this speed is still too high, the lever is moved back step by step until the desired velocity is reached.

The switches 80 shown in Fig. 1 are emergency switches which can be located in any place from which it may be desired to stop the motor.

The hand switch 45 has its blades so arranged that when it is opened a spring-actuated switch 77 closes a circuit around the shunt field coils. This circuit includes a choke coil and thus the danger of puncturing the insulation of the shunt field coils by opening the circuit is obviated.

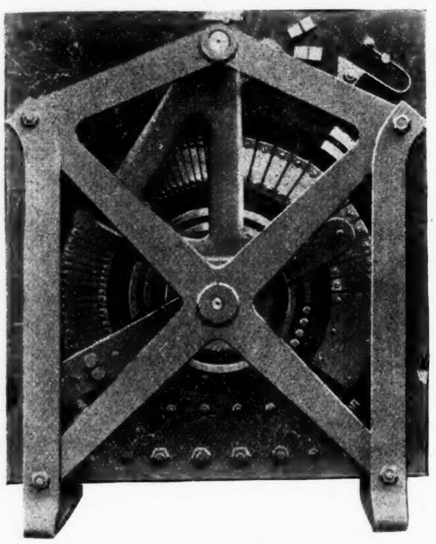


Fig. 10. Front View of Main Controller.

The electro-magnetic switches 47 and 48 can be located in any convenient position, as they are connected with the main controller through circuit wires only; but the main controller itself, must be so located that the lever 9 may be moved by means of a connection with a hand lever, as is clearly shown in Fig. 2. When the controller can be placed within easy reach of the man that operates the machine driven by the motor, the hand lever can be replaced by a wheel mounted directly upon the end of shaft 10, as is shown in Fig. 11 which illustrates a motor with the whole controlling apparatus mounted upon its back.

BEAMS AND PLANES WITH SEVERAL SUPPORTS.

Editor MACHINERY:

Some of the points in Mr. Blake's article on "Problems In Beams and Planes Severally Supported and Eccentrically Loaded," in the July number of MACHINERY, do not seem to conform to the theory of flexure of beams. Referring to Fig. 2 of his article, if the beam is supported at y and loads placed at A, B. and C, whose values are determined according to his formula, the beam will be in equilibrium, but it does not follow that the load W will produce reactions of the same magnitude at these points. If the beam were perfectly rigid and the points A, B and C would yield in proportion to the reaction brought upon them by the beam, then his formula would give the reactions; but the beam is not rigid, neither are the points A, B and C. Nor do they necessarily yield in the same proportion. It is then evident that the reactions at A, B and C depend upon the stiffness of the beam and the rigidity of the points of reaction, as well as their location.

The following simple experiment will give a practical proof of the foregoing. Place a thin yard stick so that its broad side bears for about four inches on the under side of a table leaf and arrange a support near the middle of the stick, as shown by full lines in Fig. a. A load, well within the strength of the stick, placed at the outer end will bend the stick so that the extreme end under the table leaf leaves its support entirely, and the edge of the table leaf takes the whole reaction, as shown by the dotted lines of Fig. a.

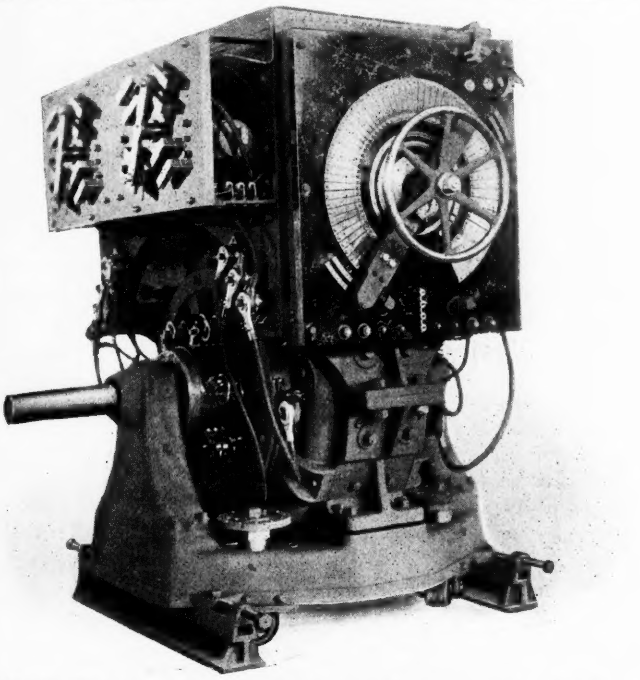


Fig. 11. Showing a Motor with all the Controlling Apparatus in Place. (See previous page).

Beams having more than two supports, as Figs. 2, 3 and 4 of Mr. Blake's article, are termed continuous beams, and the reactions at the supports depend upon the elastic curves of the beams. In other words, the bending of a beam which has more than two supports influences the reactions which occur at the supports. The imperfect adjustment or the sagging of a support of a continuous beam may cause stresses far in excess of those for which the beam was designed, and thus offset the theoretical advantage which a continuous beam has over a simple beam. The same reasoning as was applied to beams will lead to the conclusion that when planes have more than three supports the flexure influences the reactions. In the case of the four-armed spider, shown by Fig. 8 of Mr. Blake's article, if we take moments about rectangular axes we find it is not in equilibrium with the reactions as given.

The load and the reactions necessarily form a balanced system. Only three points are required to support a plane. If more are used the division of the load is arbitrary, provided the conditions of equilibrium are filled. In the following the load is divided in inverse proportion to the lengths of the arms taking $O\,A$ and $O\,C$ together and $O\,B$ and $O\,D$ together.

Then $$A + C = \frac{O\,B + O\,D}{(O\,B + O\,D) + (O\,A + O\,C)} \times 1000 = 488.37$$

$$\text{But } (A + C) + (B + D) = 1000 \qquad (1)$$

$$\therefore B + D = 511.63$$

The letters A, B, C and D in these equations represent the reactions at those points. It now remains to so proportion the sums of A and C and B and D that the system will be in equilibrium. Equation (1) and the following (2) and (3) express the conditions of equilibrium.

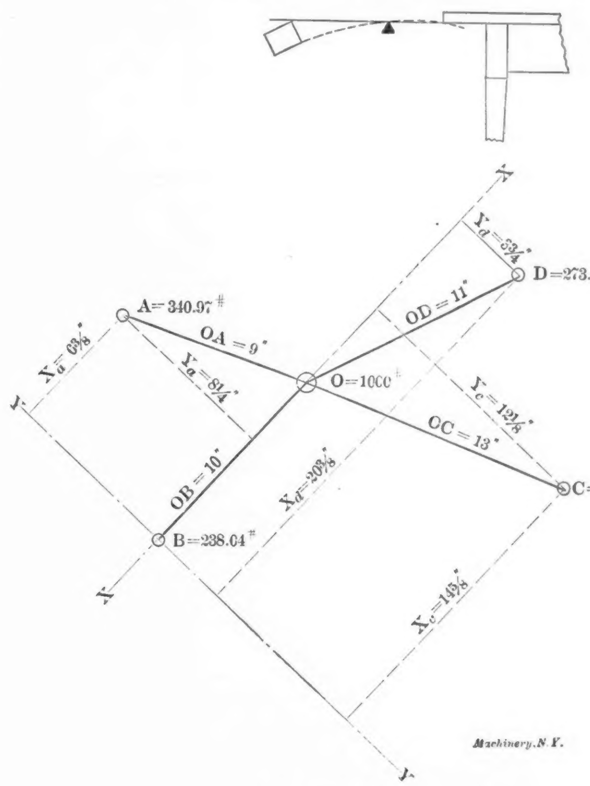
$$A\,X_a + B\,X_b + C\,X_c + D\,X_d - O\,X_o = 0 \qquad (2)$$

$$A\,Y_a + B\,Y_b + C\,Y_c + D\,Y_d - O\,Y_o = 0 \qquad (3)$$

The subscripts of X and Y indicate the point of which they are the co-ordinates, as is shown in Fig 8a, which is the same as Fig. 8 of Mr. Blake's article with the co-ordinates added. Assume the origin at B and let $O\,B$ be the X axis, then X_b, Y_b and Y_o are each $= 0$. Substituting in equations (2) and (3) the values of X and Y from Fig. 8a, we have

$$6\tfrac{3}{8}\,A + 14\tfrac{5}{8}\,C + 20\tfrac{3}{8}\,D = 10 \times 1000 \qquad (2a)$$

$$8\tfrac{1}{4}\,A - 12\tfrac{1}{8}\,C - 3\tfrac{3}{4}\,D = 0 \qquad (3a)$$



Figs. a and 8a.

from which the values of the reactions are found to be as follows:

$$A = 340.97$$
$$B = 238.04$$
$$C = 147.40$$
$$D = 273.59$$

Consequently the arms should be proportioned for these loads.

The method of proportioning the arms now needs attention. Since point O is common to all the arms, the deflection for all must be the same. Then, assuming that the maximum fiber stress is to be the same in all arms, it is necessary to design each arm so that its reaction will deflect it the same as the other arms are deflected by their reactions and at the same time produce the same maximum stress as in the other arms. Consider the two arms $O\,A$ and $O\,B$. The deflection of $O\,A$ under load A for uniform section of arm is

$$F_a = \frac{1}{3}\,\frac{(O\,A)^3 \times A}{E \times I_a} \qquad (4)$$

and of $O\,B$ under load B is

$$F_b = \frac{1}{3}\,\frac{(O\,B)^3 \times B}{E \times I_b} \qquad (5)$$

also

$$I_a = \frac{A \times (O\,A) \times e_a}{f} \qquad (6)$$

$$I_b = \frac{B \times (O\,B) \times e_b}{f} \qquad (7)$$

In which f = maximum fibre stress.

e = distance of extreme fibre from neutral axis of section.

E = modulus of elasticity.

I_a and I_b = moments of inertia of cross sections of arms $O\,A$ and $O\,B$ respectively.

Substituting the values of I_a and I_b from equations (6) and (7) in equations (4) and (5) we have

$$F_a = \frac{(O\,A)^3 \times A}{3\,E \times \dfrac{A \times (O\,A) \times e_a}{f}} = \frac{(O\,A)^2 \times f}{3\,E \times e_a} \qquad (4a)$$

$$F_b = \frac{(O\,B)^3 \times B}{3\,E \times \dfrac{B \times (O\,B) \times e_b}{f}} = \frac{(O\,B)^2 \times f}{3\,E \times e_b} \qquad (5a)$$

But these deflections are equal, hence

$$\frac{(O\,A)^2 \times f}{3\,E \times e_a} = \frac{(O\,B)^2 \times f}{3\,E \times e_b} \qquad (8)$$

Remembering that f is the same in all arms we have

$$\frac{e_a}{e_b} = \frac{(O\,A)^2}{(O\,B)^2}$$

Hence the depths of the arms should be proportional to the squares of their lengths and the moments of inertia of the cross sections should be of such value that the desired fiber stress is secured.

If the depths of the arms are to be the same where they join each other, then equation (8) becomes

$$\frac{(O\,A)^2 \times f_a}{3\,E \times e} = \frac{(O\,B)^2 \times f_b}{3\,E \times e} \qquad (8a)$$

Since e is now to be made the same, we have from (8a)

$$\frac{f_a}{f_b} = \frac{(O\,B)^2}{(O\,A)^2} \qquad (8b)$$

It is seen from this that the moments of inertia of the sections should be such that the maximum fiber stresses are in inverse proportion to the squares of the lengths of the arms. If the arms are made of uniform strength throughout their length instead of uniform section, the same results are reached by similar reasoning. E. E. GRAHAM.

Cleveland, Ohio.

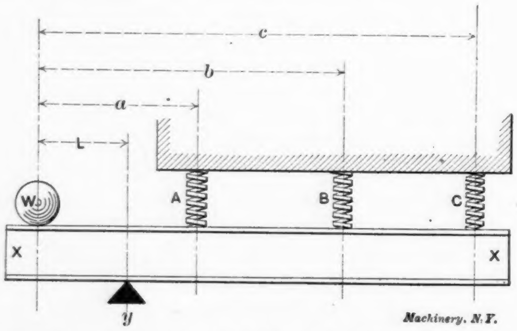
* * *

A CRITICISM.

Editor MACHINERY:

The writer is of the opinion that an erroneous idea is conveyed in the article on beams and planes severally loaded and supported, appearing in the July issue of MACHINERY.

For formulas 6, 7 and 8, in reference to Fig. 2 of the article, to be applicable one must assume the beam to be perfectly rigid, and the reactions as being uniformly elastic.



Since elasticity is one of the universal properties of matter—*i.e.*, all beams deflect—this is an impossible condition. Fig. 1 illustrates a close approach to these conditions.

If the beam XX be loaded to a fractional part of its ultimate strength, thus reducing flexure to an inconsiderate factor, and the reactions A, B and C be produced by springs of equal strength and elasticity, the distortion of the springs, *i.e.*, the amount compressed or elongated, would be proportional to their distance from the point of rotation y. Since stress is proportional to strain within the elastic limits the force at A, B and C would also be proportional to their respective distances from the point y. Now, since the magnitude of each force, and its moment, are both proportional to its distance from the point of rotation, it follows that its moment, or torque, is proportional to *the square* of this distance; hence torque due to spring

$$\left.\begin{aligned} A &= \frac{a^2}{a^2 + b^2 + c^2} \\ B &= \frac{b^2}{a^2 + b^2 + c^2} \\ C &= \frac{c^2}{a^2 + b^2 + c^2} \end{aligned}\right\}\ \text{of the total torque } W\,L.$$

If the reactions A, B and C be practically rigid in comparison to the beam, the entire load would be concentrated upon A by reason of the beam's deflection.

If the relative elasticities of the beam and the several reactions be known the resulting magnitude of the forces, the consequent moments, strains, etc., may be determined; but in practice such constructions are usually avoided, as inaccuracy of workmanship, unequal settlement or some other practical consideration would usually make the problem indeterminable. Even with theoretical conditions, if one must take into account the elastic curve of the beam, the calculations would become very complicated.

Philadelphia, Pa. JOHN S. MYERS.

* * *

ECCENTRIC LOADING.

FRANK B. KLEINHANS.

The subject of eccentric loading, although treated in a number of text books, is one that is not very clearly understood, and a few illustrations of the application of eccentric loading may be of assistance to the reader. The principle of the eccentric load, as shown in Fig. 1, is that the line of the load P does not coincide with the center line, $c\,c$, along which the reaction is taken up. This load acting at a distance L from the center of gravity of the supporting section produces a bending moment $P \times L$ about this section. At the same time we have also a uniformly distributed load over this section which is equal to P. One other thing which will be noticed is that the bending action is the same for any section $A\ B$, no matter how great or how small D may be.

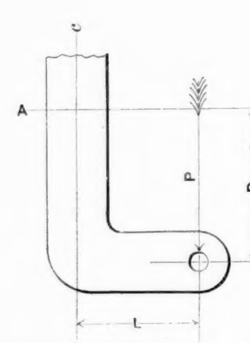


Fig. 1.

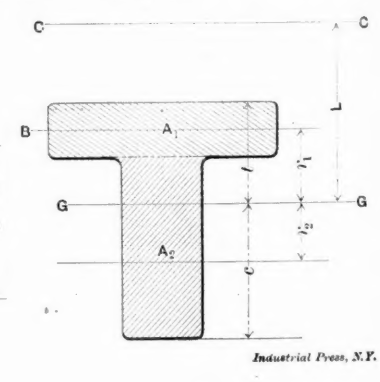


Fig. 3.

Fig. 2 represents a punching machine which must be figured according to this principle of eccentric loading. The size of the gap at A and the load determine the size and shape of the section as the frames for these machines are invariably made of cast iron, and as we cannot use as high a working stress in tension as in compression, it is advisable to make the section as shown in Fig. 3, where the amount of metal is greater on the side nearest the load. We first lay down the section to scale on a piece of heavy paper, then cut it out and balance it on a needle point, thus obtaining the center of gravity of the figure. Then draw a line $G\ G$ through the center of gravity. Now divide the figure into two rectangles A_1 and A_2, the moment of inertia of each one of which about

its center of gravity is 1-12 $B\ H^3$, in which B is the width and H is the height of the rectangle. Knowing the moment of inertia of each one of these areas about its axis as shown, we can obtain the moment of inertia about any other axis $G\ G$ thus:

Let A = total area of section,
I = moment of inertia about $G\ G$,
I_1 = moment of inertia of area A_1 about its axis,
I_2 = moment of inertia of area A_2 about its axis.

We then have:

$$I = (I_1 + A_1\, r_1^2) + (I_2 + A_2\, r_2^2)$$
$$A = A_1 + A_2$$

Let P = the load,
L = the distance from load to centre of gravity,

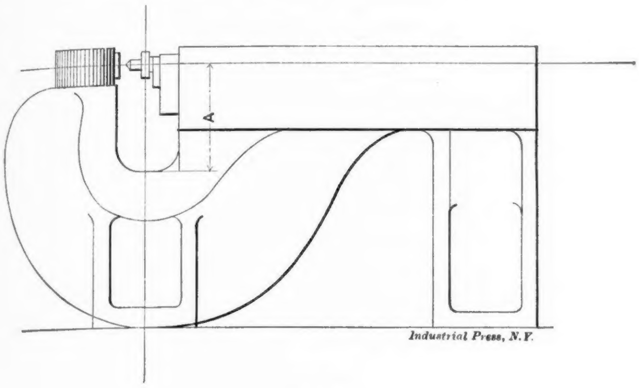


Fig. 2.

S_t = tension stress,
S_c = compression stress.

We then have:

$$S_t = \frac{P}{A} + \frac{P\,L\,t}{I}$$
$$S_c = \frac{P}{A} - \frac{P\,L\,c}{I}$$

In calculating these sections for eccentric loads, St for cast iron should not exceed 4,000 pounds, while Sc may equal 12,000 pounds. In steel castings, St would be taken at 9,000 pounds and Sc at 10,000 pounds.

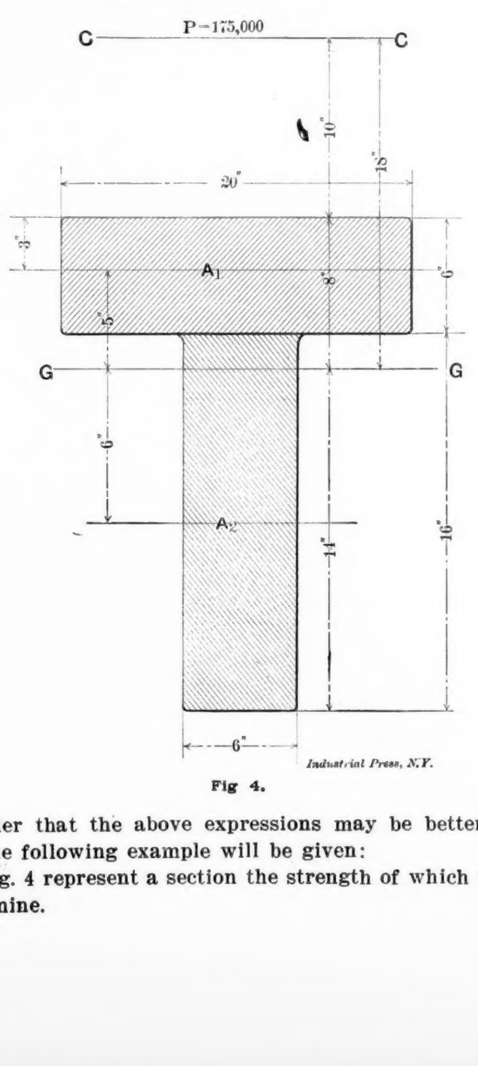


Fig 4.

In order that the above expressions may be better understood, the following example will be given:

Let Fig. 4 represent a section the strength of which we wish to determine.

We will then have

P = 175,000 pounds
$A_1 = 20 \times 6 = 120$
$A_2 = 16 \times 6 = 96$
$A = A_1 + A_2 = 216$

$$I_1 = \frac{20 \times (6)^3}{12} = 360$$

$$I_2 = \frac{6 \times (16)^3}{12} = 2048$$

$$I = (360 + 120 \times (5)^2) + (2048 + 96 \times (6)^2) = 8864$$

$$S_t = \frac{175{,}000}{216} + \frac{175{,}000 \times 18 \times 8}{8864} = 3653 \text{ tension}$$

$$S_c = \frac{175{,}000}{216} - \frac{175{,}000 \times 18 \times 14}{8864} = -\ 4161 \text{ compression}$$

As this section is for cast iron and as both stresses are within the safe working limit, the section will be satisfactory.

If the section was to be made of steel, however, it would have to be shaped like an I-beam in order to keep the stresses from running too high in compression.

A peculiar feature about eccentric loading is that with material like wrought iron, for instance, where the tension and compression should be the same, the section to resist the load cannot be made rectangular, but the tension side must be made heavier and therefore the section assumes more or less the shape of a T-iron. This fact is sometimes lost sight of and we only too frequently have a breakdown.

A cause of such a failure is shown in Fig. 5. This was the upper portion of a hydraulic punch and shear, the hook portions at H being shaped up so as to receive a steel cylinder, which fitted snugly under the flanges. The total pressure of the cylinder was therefore to be resisted by the two hook portions of the frame at H. The capacity of the machine was 100,000 pounds, and using the same notation as before, we have:

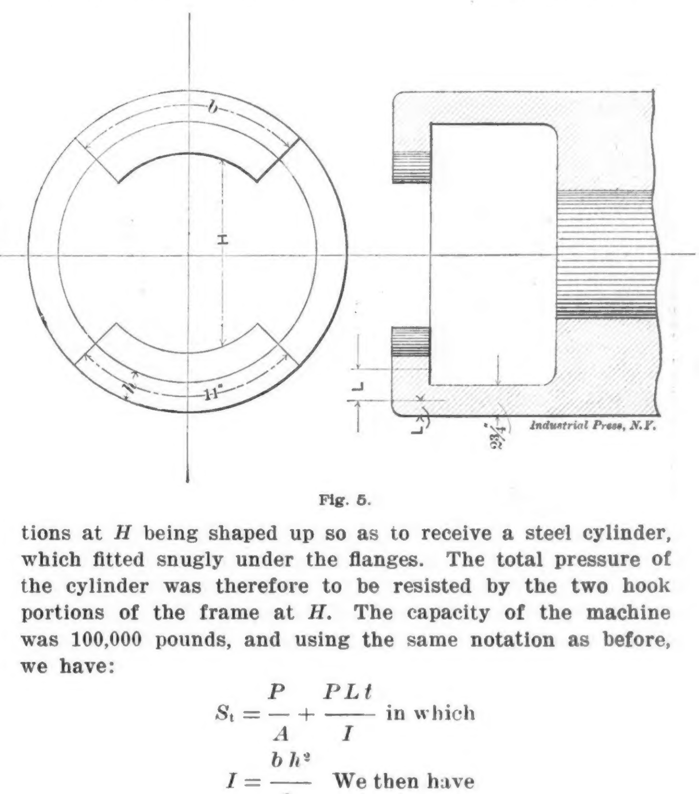


Fig. 5.

$$S_t = \frac{P}{A} + \frac{P\,L\,t}{I} \text{ in which}$$

$$I = \frac{b\,h^2}{6} \quad \text{We then have}$$

$$S_t = \frac{100{,}000}{2\frac{3}{4} \times 11 \times 2} + \frac{100{,}000 \times 2 \times 1\frac{3}{8}}{\dfrac{2 \times 11 \times (1\frac{3}{4})^2}{6}}$$

$= 1{,}600 + 10{,}000$
$= 11{,}600$ pounds stress in tension.

This should not have exceeded 4,000 pounds fiber stress and we can readily see why it was that these hook portions failed at the first application of pressure.

It is surprising to note where the action of eccentric loading comes in; in fact, a uniformly-distributed load being very rare in the members of any machine. We should, therefore, trace out the manner in which the stresses act and make proper calculations for those cases where eccentric loading occurs.

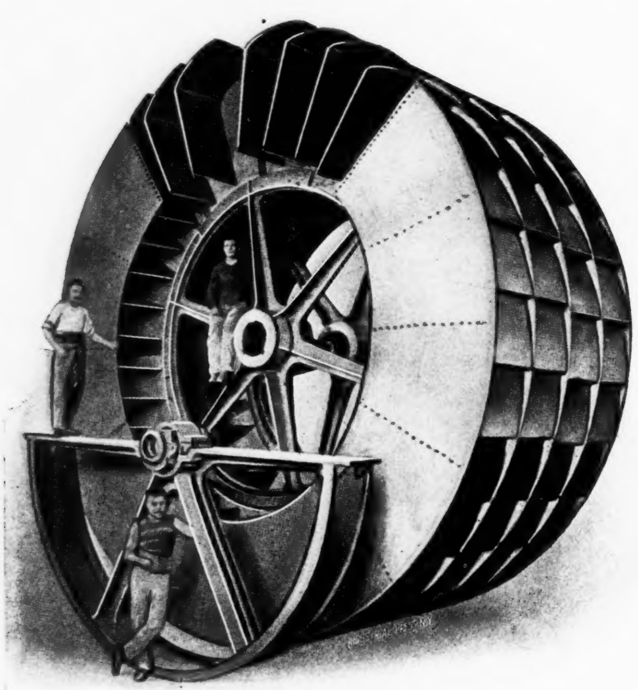
THE VENTILATOR OF THE ALBESPEYRE TUNNEL.

DR. ALFRED GRADENWITZ.

At a recent meeting of the Society for the Encouragement of National Industry, Paris, Mr. E. Denis-Farcot, Plaine St. Denis, France, read a communication on the ventilation scheme employed by him in connection with the Albespeyre tunnel.

This tunnel, situated on the Langogne-Alais line, of the Paris-Lyons-Mediterranean Co., traverses the parting of water between the Atlantic and the Mediterranean. It is a single-track tunnel, 24 square meters in cross section, 1,503 meters in length; its mean gradient is about 25 millimeters per meter.

The ventilation of the tunnel, which is traversed by rather numerous and heavy trains, presented special difficulties. The natural ventilation, being frequently opposed by violent winds, was found inefficient, and three vertical shafts, each one square meter in cross section, and 60, 120 and 150 meters in depth respectively, were sunk into the tunnel, but these afforded practically no relief. In the beginning, the trains going up grade would be pushed by an auxiliary engine placed at the rear of the train. As, however, the latter traversed an atmosphere contaminated by the smoke and gases from the engine ahead, the men in charge of the auxiliary



Mammoth Ventilating Fan.

were in serious danger of asphyxiation. So this plan was eventually abandoned, and the train divided into two parts; but as the atmosphere of the tunnel would remain in a contaminated condition for as long sometimes as 40 minutes after the passage of the train, this method did not by any means prove satisfactory.

In order to obviate this drawback, the company decided to install a system of artificial ventilation, and Mr. Farcot was entrusted with the work.

The ventilator fan which he has installed is 6 meters in diameter by 2½ meters in breadth, with vanes bent in a direction opposite to that of the rotation of the wheel, and gives an output of 150 cubic meters of air per second. The fan wheel has 64 sheet-steel vanes and is built in halves. The total weight is 10 tons. It is encased with the lower half enclosed by masonry and the upper half by a sheet-steel cover. The fan operates by induced action and the air issues through a conduit, a cross section of which increases from 9 to 21 square meters.

The fan is driven by a 150-horse-power Corliss engine, at 122 revolutions per minute. Although the speed of the fan is very little above that of the engine a belt drive was preferred to direct coupling, lest the engine obstruct the passage of the air from the fan; and, moreover, it was believed that the low temperature of the air current would seriously affect the economy of the engine.

With an output of 150 cubic meters per second, as measured at the outlet, a mean air movement as high as 7½ meters per second is obtained throughout the tunnel, resulting in a total output of 185 cubic meters, as some of the air entering at the mouth of the tunnel is carried along. This speed, however, inconveniences workmen employed in the tunnel and puts out the torches. A speed of 5 meters per second, corresponding to a total output of 120 cubic meters, is still too great; in fact, three meters should not be exceeded during the time the men are working.

The service is performed as follows: As long as no train going up grade is signalled, the ventilator runs at a low speed, viz., 50 turns per minute. On the approach of a train the speed is raised to 150 revolutions, and maintained for about 8 minutes. Four minutes are required for the passage of a train through the tunnel and an additional four minutes are necessary for clearing out the smoke.

As up-grade trains move in a direction opposite to the air current and at a speed of 25 to 30 kilometers per hour, or 7 to 8 meters per second, the air current is practically stopped during the time the train traverses the tunnel. But as a certain amount of air still surrounds the train, the atmosphere of the tunnel will remain in a condition respirable for the personnel and it has been found possible to again use the rear locomotives. As the atmosphere is renewed after the passage of each train, the front locomotive does not contaminate the air to such an extent as to seriously incommode the crew of the second.

In Mr. Farcot's communication on mechanical ventilation, recently made in Paris on the Metropolitan Railway between the Vincennes and Bastille stations, some further experiments are recorded. A ventilator, 2½ meters in diameter, giving an output of 50 to 60 cubic meters per second and being susceptible both of aspiring and blowing actions, had been installed at Vincennes, with a view to ventilating this tunnel as far as the Bastille, where the tunnel terminates in the open air. As this ventilator was in operation during the hours of service, as soon as the doors of either the Vincennes or the neighboring Nation station opened, there was produced a most violent air current which was absolutely unbearable, whereas the regular air current did not go as far as the Bastille, on account of the frequent passage of trains running in an opposite direction. By night, however, as well as outside of the working hours and whenever the doors of the station were closed, the air current would be established regularly throughout the length of the tunnel, at a speed of 1½ meters per second, corresponding with an output of 10 cubic meters.

* * *

The vitality of some totally unpractical mechanical ideas seems marvelous at first thought, but the probable explanation is the vitality of the inventors who persist in pushing them. "Poleforcia," a scheme for gaining power or, in other words, a perpetual motion machine, had its day in Philadelphia some years ago, and is now troubling the Britons. Another idea equally unpractical from a correct mechanical standpoint, which originated in America and has crossed the Atlantic, is a ball-bearing rifle gun. In this gun the ordinary rifling grooves are replaced by deep grooves in which are placed a multitude of hardened steel balls over which the projectile is supposed to ride without friction as it is discharged from the gun. No space is allowed for the balls to roll so it is difficult to understand the inventor's claim for an anti-friction bearing. The inventor appears to labor under the misapprehension that the chief resistance caused by a projectile to rapid flight is its frictional resistance in the bore, when, as a matter of fact, this resistance is but a small fraction of that due to the inertia of the projectile, in heavy ordnance.

* * *

Four-cycle gasoline engines for motor bicycle use are made that develop one brake horse power for each 20 pounds weight of motor.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The August data sheet erroneously states that watts $\times$ 746.00 = horse-power, and that horse-power $\times$ 0.00134 = watts. The factors should be transposed so as to read: Watts $\times$ 0.00134 = horse-power, and horse-power $\times$ 746 = watts.

A correspondent of the *Woodworker* says that a good rust joint mixture is made of ten parts of iron filings (or borings) to three parts of chloride of lime. Mix into a paste with water, apply to joint and clamp together. In twelve hours it will be set solid.

The old New Bedford whalers are mines of copper wealth according to *Marine Engineering*. The timbers were heavy and white oak put together "on honor" which apparently meant the liberal use of copper fastenings. It is said that from \$2,000 to \$3,000 worth of scrap copper is often realized when one of these old vessels is broken up.

A novelty in time-keeping devices is a handless clock which shows the time in hours and minutes on direct-reading celluloid tablets. These tablets or leaves are arranged in two rows around a vertical cylinder, each leaf being pivoted to the outside of the cylinder, and on the "face" portion of the cylinder they are turned in opposite directions like an open book. As the cylinder turns successive leaves flip over from one side to the other, thus exposing the successive figures denoting the hours and minutes.

In a recent interview Mr. Charles M. Schwab, the former president of the United States Steel Corporation, said that in 1879 the steel production of this country was 1,000,000 tons per annum; in 1889 it had increased to 7,000,000 tons; and in 1899 it was from 12,500,000 to 15,000,000 tons. The consumption is now 15,000,000 to 16,000,000 tons a year and in ten years will be over 20,000,000 tons. The consumption of steel rails required to replace those worn out is 2,500,000 tons annually, and 600,000 tons are used in the manufacture of steel cars.

The true and, therefore, persistent inventor is satisfied with no device or product; he is continually working out new combinations or changes in the things previously created. Even the humble carpet tack has not been allowed to retain its original concrete form, but in a new shape it assails our eyes, having a double head arranged tandem fashion, one over the other. The true inwardness of this invention is not, as might be imagined, to foil its peculiarly fiendish propensity for standing upright on chair seats or on the floor awaiting the bare foot of the unsuspecting night prowler, but to facilitate its removal from the floor in spring house cleaning time.

Men get the notion into their heads that you cannot run wood-working machinery fast enough, and speed up their planers and saws to the last limit. This is probably the poorest kind of policy. Saws running above a normal speed will not run as easy or do as good work as at much lower speed. If any one does not think so, let him take a common bench saw, speed it up high and feed it by hand himself. He will soon find that the stock pushes hard. Then he concludes the saw is dull. After filing, he tries it again, with the same result. The trouble is, one cut follows the other too quickly and glazes it over. Every wood-working machine shows the same effect following a too high speed. There is a normal speed for saws and planers.—*Woodworker.*

The liquid condition of petroleum is ordinarily an advantage when considered for fuel purposes, but sometimes it is a decided disadvantage, especially when it is to be used temporarily in coal furnaces or where the conditions are such that the liquid fuel is a grave fire risk. Considerable attention has been given to briquetting petroleum so as to make it available where liquid fuel is not permissible. A recent consular report gives a brief outline of a German process for petroleum briquetting which appears simple and apparently requires practically no machinery. To one quart of petroleum is added soft soap, 150 grains; rosin, 150 grains; and caustic soda lye wash, 300 grains. The mixture is heated and thoroughly agitated. This takes about forty minutes and during this time care must be taken to prevent the liquid running over; this is achieved by adding a little soda. The mixture is poured into briquette molds to solidify and allowed to cool, after which the briquettes are dried in an oven for an hour or two.

NEW GALVANIZING PROCESS.

A new process of galvanizing, known as "Sherardising," has been developed abroad to a commercial basis, which promises to overturn the present hot galvanizing process used on iron and steel. By the new process the work is covered with an even coating of zinc without dipping it into a molten bath, and it is done at considerably less than the melting temperature of zinc so that the deteriorating effect of high temperature is considerably reduced. The work to be galvanized is thoroughly cleared of surface oxide or rust by sand-blasting, acid bath or other preferred means, and is then placed in an air-tight cast iron muffle or oven charged with the zinc dust of commerce. After being kept at a temperature of from 500 to 600 degrees F. for a few hours, the work is removed and allowed to cool. The process of coating with zinc has been perfectly effected during the baking process; the thickness of the coating of zinc depends upon the time the work is kept in the muffle. The galvanizing is thus done at a temperature about 200 degrees less than that necessary by the hot bath process; moreover, it has the advantage of wasting none of the zinc. The waste of zinc by the common process is a quite considerable percentage of the total amount of the bath. Although common bar zinc melts at something over 700 degrees F., the zinc dust of commerce does not melt at an even much higher temperature, so that there is no danger of its melting in the muffle.

THE TELEPHONE PARADOX.

A writer in the New York *Times* explains the "telephone paradox," that is, why the cost of telephone service per subscriber instead of decreasing with an added volume of business, increases at a faster rate than the increase of subscribers.

"The switchboard in the exchange is built in sections, each of which contains on an average the terminals of the lines of 200 incoming subscribers. These terminals are called 'jacks,' and the panel containing them is called the answering panel. In addition to these 200 incoming jacks, each section must contain the outgoing jacks of each subscriber in the exchange. This is necessary in order that the operator in each section may be able to connect any of the incoming subscribers in a section with any other subscriber in the exchange. The panel containing these outgoing jacks is called the multiple panel. On the above basis the switchboard in an exchange of 2,000 subscribers, would contain ten sections, that of a 5,000 exchange 25 sections, and that of a 10,000 exchange 50 sections; consequently each section in exchanges of these capacities would contain respectively 2,200 jacks, 5,200 jacks, and 10,200 jacks. The total number of jacks in a 2,000 exchange is therefore 22,000. The average mind would at once arrive at the conclusion that the total number of jacks in a 5,000 switchboard would be two and one-half times that of a 2,000, or 55,000, and that the total number in a 10,000 switchboard five times that of the 2,000. A 5,000 capacity switchboard, however, would contain twenty-five sections of 5,200 jacks each, or a total of 130,000, while a 10,000 capacity switchboard with its fifty sections of 10,200 jacks each, would contain 510,000 jacks. For sake of argument, we will say that each jack with its connection and labor, represents a cost of \$1. Each new subscriber added to a 2,000 exchange has to be 'multiplied' into ten sections, necessitating ten jacks; but each new subscriber added to a 5,000 exchange has to be 'multiplied' into

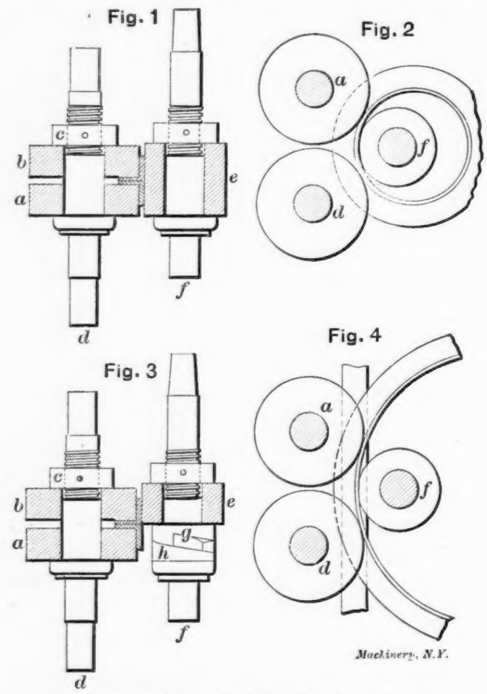
twenty-five sections, requiring twenty-five jacks; while each new subscriber added to a 10,000 exchange has to be multiplied into fifty sections, requiring fifty jacks. Now, as to the number of 'hello girls' necessary to operate exchanges of the size mentioned. While one operator can take care of each section of a 2,000 capacity switchboard, the larger exchanges require three or more operators per section, besides assistants, relief operators, and monitors. It is, therefore, evident that a company starting out with 2,000 subscribers, on a basis of say $50 per year for service, makes less profit on each 200 subscribers added; and such is the decrease in the profit as the exchange mounts up to 5,000 or 10,000 that the company must either increase its rates or quit.

"One of the most interesting exhibits in the St. Louis Exposition is that of the invention of a German named Faller, who has succeeded in eliminating the multiple feature, not only from automatic practice, but also from present manual practice. So great are the savings effected by this elimination of the 'bugaboo' of telephony that we may, in the near future, look for, not only much lower rates, but also what is almost as much to be desired—infinitely better service."

METHOD OF BENDING ANGLE BARS.

Energie, December 5, 1903, p. 3.

When an attempt is made to bend angles into a circular form it frequently happens that the ends do not close because the varying resistances of the different parts of the section throws these ends out of the same plane. In order to avoid this trouble Kottgen & Co., of Barmen, have designed the apparatus shown in Figs. 1, 2, 3 and 4. The principle of operation is to set the angles back to back so that the varying forces



Illustrating Method of Bending Angle Iron.

in each are working in opposite directions to each other and thus hold them in the same plane. Figs. 1 and 2 show the apparatus as arranged to bend two angles at the same time. If but one angle is to be bent the arrangement shown in Figs. 3 and 4 is used. The regulating screw *g* and *h* makes it possible to so adjust the roller *e* that it only acts upon one angle, which is so guided by the other that it is prevented from turning out of its own true plane. G. L. F.

THE ACTION OF PUMPS.

Practical Engineer, August 5, 1904.

From a hasty and superficial consideration no mechanical operation appears simpler than pumping fluids, whereas, under some considerations, it requires most carefully-designed machinery, and a thorough grasp of all the effects of moving fluids, before the operation can be successfully accomplished. Referring in the first place to the suction action of a pump, the plunger is followed by a plug of water in the whole length of the suction piping, and the effect of this water may be likened to so much dead weight added to the plunger, the inertia of which will be felt by the reciprocating parts and the crank pin. This action will show that an air chamber on the suction is a very necessary provision where the length of suction pipe is considerable. Turning now to the delivery action, we have, when the pump is about to commence its stroke, the whole mass of water in the pump chamber and the rising main inert, and this mass is suddenly set in motion by the advance of the plunger. It is clear, therefore, that severe shocks will occur where the delivery pipe is of great length. The above conditions exist where the valve action of the pump is perfect, but when faulty valves are present further shocks will be encountered. Consider, for instance, the effect of a sluggish closing of the delivery valves. When the plunger has attained its extreme stroke and begins to return, it will be followed by the whole volume of water in the rising main, but this motion will only continue so long as the delivery valve remains open. When this has closed the motion will be suddenly arrested, and great shocks will be felt unless air chambers are provided. In addition to the actions just described, there is the effect of a sluggish action on the part of the suction valves, as well as the effect of a restricted suction passage, but enough has already been said to indicate the nature of the shocks encountered by pumps. When these are considered, the frequent fractures and breakdowns which occur will not appear to be very mysterious; and this article will have served its purpose if it will lead some designers to realize that pumps have to withstand other stresses than those due to the mere statical head of the fluid.

THE ENGINEER AS A BUSINESS MAN.

Extract from Address by A. C. Humphreys to the Students of University of Wisconsin.

About eighteen years ago I was called in to examine a process for which it was claimed that from two barrels of oil could be produced 200,000 feet of gas, high in candle-power and high in calorific-power. The promoters were able to produce, in verification of their claims, certificates from a number of gas engineers, and, I am sorry to say, from two professors of high reputation, members then of the faculty of a prominent engineering college. The certificate of one of these professors stated that the volume of gas produced under his observation confirmed the claim as to volume. The other professor's certificate stated that the gas produced had been found to be equal in candle-power and calorific-power to the claims. I noticed, however, that these certificates showed that the work on volume and the work on intensity or quality had been performed on different days. I was reluctant to undertake an investigation because manifestly the claims were ridiculous. On account of several people strong in the financial world, friends of our company, being concerned I was finally persuaded to undertake the investigation. I went off with a number of my men, set up the apparatus and left it in charge of a man who is now my partner and who at that time had only recently graduated from Stevens Institute. In giving him his instructions I told him that when he signed his report it would be necessary for him to bear in mind that when he affixed his signature I should understand that every word in his report he was personally responsible for; that he had taken nobody's word for anything, even to the minutest detail. He made the remark that this would be liable to put him into some very embarrassing positions. I told him it was sure to do so. Being a very polished Southern gentleman, this was evidently very disagreeable to him. The work went on for six weeks. We were constantly hampered by objections to the measures we were taking for the final determination. I visited the works myself once a week and it was apparent finally that oil was being introduced to the apparatus surreptitiously and I told my men to find the hidden pipe which was so being used. Shortly after my return from this last visit I received a telegram from my assistant in charge saying: "Have discovered the pipe. Can do nothing unless I seal the valve. This will indicate a lack of confidence. What shall I do?" I wired back: "You have your instructions and know what will be expected if you sign the

report." I received another telegram in reply: "Valve sealed." The next morning I got another telegram: "Works burned down, valve, seal, and all." So we had finally forced them to face a disclosure of the fraud and they preferred to have an accident at the works.

THE RESISTANCE OF EMERY WHEELS TO RUPTURE.

La Revue Technique, June 25, 1904, p. 660.

The Prussian government have fixed a maximum limit to the circumferential speed of emery wheels. For wheels made with a vegetable binder this limit is 82 feet per second, and for those with a mineral binder it is 49 feet per second. In the opinion of some German engineers, these figures seemed too low, and Prof. Grubler was commissioned to ascertain the bursting speed of wheels of different sorts.

The apparatus used consisted of an arbor 2 inches in diameter which is guided at the upper end by two collars held between two horizontal plates, set about 7⅞ inches apart. These latter were supported by two I-beams set about 11 inches apart. The wheel is centered and mounted at the lower end of the shaft. The whole rested upon a block 11⅞ inches thick, which in turn was supported on the sides of a trough nearly 4 feet deep and about 35½ inches wide. The arbor is driven by means of a grooved pulley over which a cord runs, and which can be driven by an electric motor at a speed of 1,600 revolutions per second. This latter can, however, be regulated at will, and a tachometer, driven by gearing, indicated upon a dial the speed at any instant. The wheels were fastened to the arbor by two metallic disks of 7⅞ inches diameter between which felt washers were screwed.

As the speed of the wheels was increased two critical values were brought out that were characterized by the more or less violent vibration of the shaft. They were caused by its elasticity and the torsion of the supports. They did not appear to bear any ratio to the speed of rupture or the explosion of the wheel, but are the more pronounced as the center of gravity of the wheel varies from the center of rotation.

From theoretical consideration alone it would appear that the maximum stress carried by the wheel is to be found at the circumference of the circular hole in contact with the shaft, and an examination of the broken wheels showed that the cracking had proceeded from the center to the circumference.

These wheels were all about 19⅝ inches in diameter, and the highest speed attained was 4,340 revolutions per minute, or 374 feet per second at the periphery.

As an expression of the safe speed the following formula has been deducted which gives the value of the maximum tension t of a wheel with an internal diameter i, an external diameter e, a specific weight w, and a circumferential speed u. With metric measurements the formula is

$$t = \frac{3\,w}{4\,g}\,u^2\left[1 + \frac{1}{3}\left(\frac{i}{e}\right)^2\right]$$

which when referred to English measurements becomes

$$t = \frac{w\,u^2}{62\,g}\left[1 + \frac{1}{3}\left(\frac{i}{e}\right)^2\right]$$

g being the acceleration of gravity.

By adopting 10 as a coefficient of safety, the above formula gives the following as the safe peripheral velocities of various types of wheels:

	Feet per Second.
Wheels with a vegetable binder (rubber)	102
Wheels with a mineral binder (magnesia)	88½
Wheels with a porcelain binder	78

G. L. F.

RESISTANCE OF RAILWAY TRAINS.

Zeitschrift des Oesterreischischen Ingenieure Vereins, December, 1902.

The author, after having reviewed the trials of M. F. Barbier on the Northern Railway of France on the resistance of trains, gives the results of other independent tests of the same kind to secure similar data regarding Austrian rolling stock. The result of these experiments has been presented in the same form as those of Mr. Barbier, and the formula derived is $R = a + bV + cV^2$, in which R is the resistance of the car in kilograms per ton of material, V the speed in kilometers per hour, and a, b and c constants which are then reduced to a graphic formula where the several factors are set forth.

These tests were not made by means of indicators and dynamometers, but by observing the speeds and accelerations which the vehicles attained upon different grades, a speed that amounted to from 36 to 48 miles an hour, and sometimes held this for a comparatively long time. In the matter of cars at least 323 trains were used whose weight, length and composition were varied to correspond with the condition of actual service.

The author also notes the difference between this method of testing and the dynamometer method, of which he has made no use. He also gives the principal dimensions of the vehicles used and the curves obtained, not only by himself but by Leitzmann, Wittenberg, Clark and others in former researches. Among other formulæ given are $R = 3.8 + 0.025V + 0.001V^2$ (between 24 and 48 miles an hour) for a 4-4-0 compound locomotive weighing 55.6 tons and having a six-wheeled tender weighing 36.7 tons in working order, attached; and $R = 1.6 + 0.184V + 0.00046V^2$ for four-wheeled cars weighing from 11 to 15 tons.

In conclusion, M. Sauzin summarizes the numerous influences which tend to modify the resistances of trains, such as wind, exposed areas, lubrication, temperature, etc.

G. L. F.

MAKING CASTINGS IN ALUMINUM.

Practical Engineer, July 15, 1904, p. 75.

The method adopted in preparing molds and cores for aluminum work is necessarily somewhat the same as for brass, but there are particular points which need attention to insure successful work. Both in the sand and the making of the molds there are some small differences which make considerable variation in the results, and the temperature at which the metal is poured is a consideration of some importance.

In selecting the sand, which should not have been previously used, that of a fine grain should be chosen, but it should not have any excess of aluminous matter, or it will not permit of the free escape of gases and air, this being an important matter. Besides this, the sand must be used as dry as possible consistent with its holding against the flow of the metal, and having only moderate compression in ramming.

In making the molds it is necessary to remember that aluminum has a large contraction in cooling, and also that at certain temperatures it is very weak and tears readily, while all metals shrink away from the mold when this is wholly outside the casting, but they shrink on to cores or portions of the mold partly inclosed by metal. Thus, if casting a plate or bar of metal, it will shrink away from the mold in all directions; but if casting a square frame, it shrinks away from the outside only, while it shrinks on to the central part or core. With brass, or iron, or such metals, this is not of much importance, but with some others, including aluminum, it is of great importance, because if the core or inclosed sand will not give somewhat with the contraction of the metal, torn or fractured castings will be the result. Both for outside and inside molds, and with cores used with aluminum, the sand should be compressed as little as possible, and hard ramming must in every case be avoided, particularly where the metal surrounds the sand. The molds must be very freely vented, and not only at the joint of the mold, but by using the vent wire freely through the body of the mold itself; in fact, for brass the venting would be considered excessive. With aluminum it is, however, necessary to get the air off as rapidly as possible, because the metal soon gets sluggish in the mold, and unless it runs up quickly it runs faint at the edges. The ingates should be wide and of fair area, but need careful making to prevent them drawing where they enter the casting, the method of doing this being known to most molders.

If it is considered desirable to use a specially made up facing sand for the molds where the metal is of some thickness, the use of a little pea or bean meal will be all that is necessary. To use this, first dry as much sand as may be required and pass through a 20 mesh sieve, and to each bushel of the fine sand rub in about 4 quarts of meal, afterward again passing through the sieve to insure regular mixing. This sand should then be damped as required, being careful that all parts are equally moist, rubbing on a board being a good way to get it tough, and in good condition, with the minimum of moisture.

The molds should not be sleeked with tools, but they may be dusted over with plumbago or steatite, smoothing with a camel's hair brush, in cases where a very smooth face is required on the castings. Preferably, however, the use of the brush even should be avoided. Patterns for aluminum should be kept smooth and well varnished, as the better the face of the pattern the smoother the mold is left, as a rule, a point worthy of consideration in relation to the making of molds for casting all kinds of metals and alloys.

In melting the metal it is necessary to use a plumbago crucible which is clean, and which has not been used for other metals. Clay or silica crucibles are not good for this metal, especially silica, on account of the metal absorbing silicon and becoming hard under some conditions of melting. A steady fire is necessary, and the fuel should reach only about half way up the crucible, as it is not desirable to overheat the crucible or metal. The metal absorbs heat for some time and then fuses with some rapidity; hence the desirability of a steady heat, and as the metal should be poured when of a claret color under the film of oxide which forms on its surface, too rapid a heating is not advisable. The molding should always be well in advance of the pouring, because the metal should be used as soon as it is ready; for not only is waste caused, but the metal loses condition if kept in a molten state for long periods. The metal should be poured rapidly, but steadily, and when cast up there should not be a large head of metal left on top of the runner. In fact, it is rather a disadvantage to leave a large head, as this tends to draw rather than to feed the casting.

With properly prepared molds, and careful melting, fluxes are not required, but ground cryolite—a fluoride of sodium and aluminum—is sometimes used to increase the fluidity of the metal. In using this, a few ounces according to the bulk of metal to be treated is put into the molten metal before it is taken from the furnace, and well stirred in, and as soon as the reaction apparently ceases the pot is lifted and the metal at once skimmed and poured. The use of sodium in any form with aluminum is very undesirable, however, and should be avoided, and the same remark applies to tin, but there is no objection to alloying with zinc, when the metal thus produced is sold as an alloy.

Aluminum also casts very well in molds of plaster of paris and crushed bath brick when such molds are perfectly dry and well vented, smoothness being secured by brushing over with dry steatite or plumbago. When casting in metal molds, these should be well brushed out with steatite or plumbago, and made fairly hot before pouring, as in cold molds the metal curdles and becomes sluggish, with the result that the castings run up faint.

SUPERHEATED STEAM FOR LOCOMOTIVES IN GERMANY.

Abstract of Consular Report No. 2,016 by Dean B. Mason, Berlin, Germany.

Since the year 1898 the Prussian State railroads have been carrying on experiments with locomotives using superheated steam, and these experiments have done much to elucidate and overcome the technical difficulties incident to the use of superheated steam by locomotives. While during the last ten years the utilization of superheated steam with stationary engines has become general in Germany, it has been employed only on a small scale, during the past few years, with locomotives. Owing to the great amount of power which a locomotive of limited size must produce, it is far less economical of steam than the stationary engine, whose bulk is subject to no limitation, and its steam is far more heavily charged with moisture, so that theoretically, at least, the advantages obtained by the use of superheated steam in locomotives should be greater than in stationary engines.

The first two engines equipped with Schmidt superheaters, put into service in 1898 by the Prussian State railroads, are still running, and after various modifications had been made they gave, according to an official report, entire satisfaction, and are to-day considered two of the best simple engines for express and ordinary passenger service, in spite of the fact that they are in various respects not up-to-date in construction. The next order was for four simple locomotives in which the superheater was placed in the smokebox instead of in the boiler, and all of these engines have proved satisfactory, according to the report of Baurath Garbe, in respect to power, economy in the use of water and coal, and the ease with which they start. At present there are some 50 locomotives equipped with the Schmidt superheater in use or in course of construction for the Prussian State railroads, and all the different types of locomotives at present in use on this system are being tried with the Schmidt superheater. No official reports of the results obtained have been published more recently than 1902. In an article published by C. W. Kriedel, of Wiesbaden, the results shown by the tests made public up to that time were summed up as follows:

Locomotives using superheated steam under favorable conditions use 5 per cent. less coal and 15 to 20 per cent. less water than engines using saturated steam; owing to its lightness, superheated steam is especially effective when the action of the piston is very rapid; and greater power for a short time can be maintained by engines using superheated steam than by those using saturated steam.

Brückmann, one of the most indefatigable and exhaustive investigators, calculates that under normal conditions there is a saving of 20 per cent. in an ordinary simple steam engine that employs superheated steam over one that does not, while the saving in coal is only one-half per cent. when the work of a simple engine with superheater is compared with that of a compound engine without it. Owing to the difficulty of obtaining absolute accuracy, the results of the various tests of the efficiency of locomotives using superheated steam as compared with other engines have varied considerably, and there exists more or less difference of opinion as to the limit of economy in fuel and water that has been and is likely to be attained by the use of superheated steam.

Geheimrath Garbe maintains that in considering the question of expense the simple engine with superheater should be compared with the compound locomotive. He maintains that the use of the compound engine has been rendered desirable only by the defects of ordinary steam, that with highly superheated steam the simpler and less expensive twin engine, working with steam at much lower pressure, is capable of taking its place for all purposes, and that it will be possible by the use of superheated steam to reduce the types of engines used in Germany to five or six. He asserts that while the compound engine is more economical, is capable of attaining greater speed, and is more powerful at high speed than the simple engine when ordinary steam is used by both engines, the advantages of the compound engine disappear when it is compared with a properly constructed simple engine using superheated steam at from 570 to 620 degrees F. He bases his judgment on experience obtained on the Prussian railroad and on the inherent superiority of highly superheated steam.

The most recent trial that an engine equipped with the Schmidt superheater has undergone was at the high-speed steam locomotive tests made on the track between Marienfelde and Zossen, when an engine built by the firm of Borsig and equipped with a Schmidt superheater made a speed of 79½ miles with a full train of six cars, and a speed of 84½ miles an hour with a train of three cars, the energy developed being about 2,000 horse power. The Borsig engine, unlike the three other engines, was not built specially for these trials, but only one of its competitors equaled it in speed.

It is likely that the Schmidt superheater would have been adopted already on a much larger scale were it not for the opposition which it has encountered from the partisans of

other superheaters. Encouraged by the success obtained by Schmidt, other inventors have taken up the same line of work and have produced superheaters of varying degrees of practicability. Of these the Pielock is the one that has received the most attention in this country, and would appear to be the most serious competitor to the Schmidt invention. It consists of a chamber or metal box located in the boiler, from which it is separated by a metal wall through which the boiler flues pass. The interior of the superheater is divided up by walls in such a manner that the steam in passing through the different subcompartments is made to circulate along the boiler flues. Owing to the risk of injury to the flues, it has not been found desirable to place the superheater too close to the furnace. The temperature in the furnace flues is reduced by passing through the water of the boiler, and the temperature attained by the stêam in the superheater is from 450 to 500 degrees F.

As will be seen by the foregoing, there exists a radical difference between the Schmidt and Pielock superheaters. While in the former the steam is heated to from 570 to 620 degrees F. by means of one large flue, which conveys part of the furnace gas to the superheater chamber, in the Pielock system all the furnace gas is passed through the superheater by means of the boiler flues, the steam being heated only from 450 to 500 degrees F.

In all, some ten engines have been or are to be equipped with the Pielock superheater by the Prussian State railroads, but it has not been possible to obtain satisfactory information as to the results recently obtained. Only old engines have been experimented with, one of the principal advantages of the Pielock over the Schmidt superheater being that old engines can be equipped with it without expensive alterations. In order to equip an engine with a Schmidt superheater capable of giving the steam a high temperature it is necessary to enlarge the smokebox in order to make room for the superheater, and in case the superheater is made smaller, the old smokebox being retained, it is possible to obtain only moderate temperatures, similar to those obtained by the Pielock system.

It is claimed for the Pielock superheater by its inventor that it can be used on old as well as new locomotives, as it can be adjusted to any boiler, and that no loss of power is entailed, as owing to the greater efficiency of the superheated steam, the space taken up in the boiler is more than compensated for; that owing to the simplicity of construction of the Pielock superheater it is cheaper than any other type, costing from $450 to $600 only for a two or four-cylinder Prussian express locomotive; that with it there is no loss from radiation, as any heat lost in the superheater raises the temperature of the water in the boiler; that it is less subject to repair than any other superheater, and needs no special cleaning other than the cleaning of the boiler flues, which would have to take place anyway; and that no extra labor is entailed on the part of the locomotive engineer.

It is claimed by the adherents of the Schmidt system that it is impossible to obtain sufficient increase in efficiency with the moderate temperature attained by the Pielock superheater to justify its use; that frequent repairs to the furnace flues passing through the superheater will be inevitable; that they cannot be examined without being taken out; that this involves serious damage to the superheater and to the walls to which they are made fast; and that a flue thus removed cannot be used again. The partisans of the Pielock system claim, on the other hand, that the large furnace flue used in the Schmidt system is likely to leak where it is connected with the superheater; that the highly superheated steam is very injurious to the machine parts which it comes in contact with; and that too much heat goes out of the smokestack.

WATER HAMMER IN STEAM PIPES.

The Locomotive, July, 1904.

Attention should be called to the danger of putting in steam pipes in such a way that they can act as traps, and collect any considerable quantity of water of condensation. When steam is turned into a pipe containing entrapped water, it is unfortunately common experience that the entering steam causes the water to surge about in some way that is not entirely understood, so that it is often thrown against the fittings with such violence as to cause some part of the pipe line, or its connections, to break. The reality of the danger from entrapped water in piping is often disputed by those who have not seen its results; but the extensive experience of the Hartford Steam Boiler Inspection and Insurance Company indicates that accidents from this cause not only happen, but happen often. In the following they give several cases of the kind that have recently come under their notice.

Figs. 1, 2 and 3 represent certain steam connections which gave trouble, not long ago, in an electric lighting plant. The boilers were of the water-tube type, with three drums each; the drums of one of these boilers being shown. Immediately

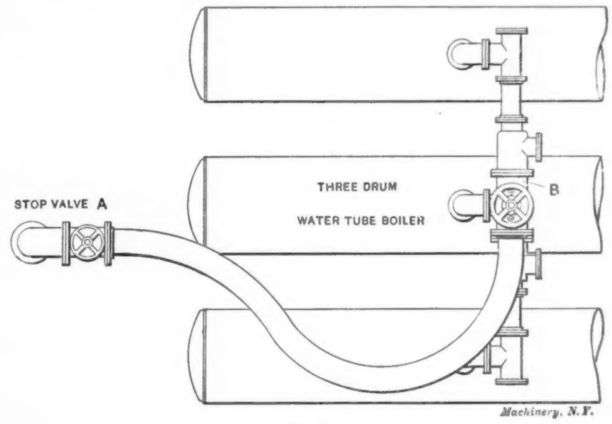


Fig 1.

upon the top of this boiler there was a safety stop valve, *B*, which was designed to close automatically in case of any abnormally violent rush of steam through the feeder to which it was attached. This automatic valve was closed at the time of the accident, and another stop valve, *A*, situated on the same feeder where it entered the main, had also been closed. The boiler had been out of service for a time, but pressure had been raised upon it again, and it was about to be "cut in" with the other boilers in the battery. For this purpose the stop valve *A* was opened, the intention being to open the automatic valve, *B*, immediately afterward. It is probable that, owing to leakage through one or the other of the two valves, there had been an accumulation of water in the space between these valves; the entering steam causing this water to surge around through the curved pipe in such a way as to throw it violently against the automatic valve. At all events, the stop valve, *A*, was hardly opened when a section of the casing of the automatic valve was knocked out, as indicated by the shaded area in Fig. 3; several men who were standing near by being also scalded. Where two valves are used on a steam pipe in this manner, provision should always be made

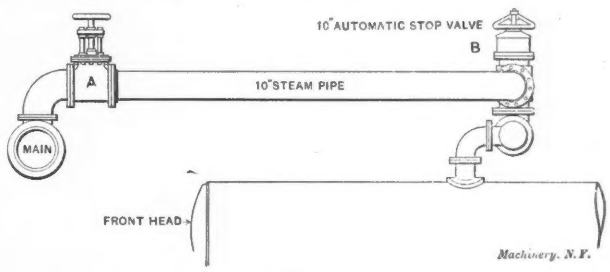


Fig. 2.

for draining the space between them before either valve is opened; and when one of the valves is opened, it should be opened very slowly indeed. Furthermore, before any considerable quantity of steam is admitted to the pipe, both valves should be eased off from their seats slightly, to establish a moderate circulation, this being allowed to continue for some moments before the valves are opened further.

Fig. 4 illustrates another case, quite similar in its general aspects to the one described above. The boiler was here of the vertical water-tube type, and there was a gate valve in the branch pipe near the boiler, as well as a globe angle valve where the branch pipe entered the large main. From the circumstances attending the accident here under consideration,

and from the close similarity between it and other accidents in which water-hammer was undoubtedly the chief and perhaps the sole factor in determining the destruction, we are confident that this was also a case of water-hammer action. There had undoubtedly been leakage through one or both of the valves shown, so that the steam pipe had become more or less filled with water. At any rate, when the valve *B* was opened, the casing of the valve *Y* was almost immediately fractured, being broken into several pieces. It will be understood that in an accident of this kind it is often very difficult indeed to prove, beyond further argument, just what the cause was. In the present case, it has been pointed out that the valve *B*, being a gate valve, would naturally not be opened very rapidly; and it has

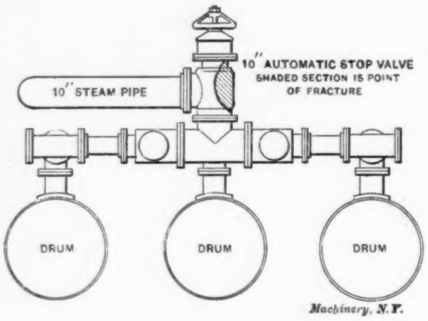


Fig. 3.

been argued that this lessens the probability that the accident was due to water-hammer action. However, the fact remains that the casing of the broken valve appears to have been abundantly strong to withstand any strain that could legitimately come upon it in its natural service, and, moreover, an examination of the fractured areas of the casing showed that they were sound, and without defects. It is also certain that the pipe would have trapped water if either of the valves had leaked, and that the accident occurred immediately upon steam being admitted through the valve *B*. Taking these various circumstances into account, assurance is felt that the cause was either water-hammer, or the sudden lifting of water from the boiler itself, as the steam was carried over into the comparatively cold pipe. Of these two explanations, that which assumes the presence of entrapped water appears to us to be the more probable, because, unless the gate valve, *B*, were opened with very unusual quickness, it is not probable that any great amount of water would be actually lifted from the boiler and thrown with violence down to the valve *Y*.

Drips are excellent things on a pipe line, if they are faithfully used; but there is a temptation to neglect them, after the attendant has operated the plant for a considerable time without trouble, and it is always better to design the pipe line so that no drips will be necessary, the pipe emptying itself by the natural action of gravity. The same precaution may be

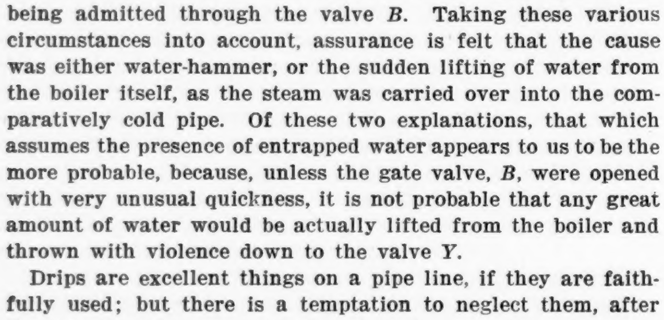


Fig 4.

repeated here which was mentioned above—namely, in throwing a boiler into service which is connected with the main steam line by a pipe containing a double valve, the valves should be opened very slowly, each being eased from its seat and allowed to stand for a time, until the pipe becomes thoroughly heated, and any entrapped water that it may contain has had an opportunity to pass away.

In Fig. 5 is illustrated another accident, in which water-hammer was more evidently the cause of the trouble. In this case, the feeder pipe from the boiler to the main was bent, in order to clear a fore-and-aft line of pipe. There was only one valve in this instance, between the main pipe and the boiler; but it is easy to see that with the boiler out of service, and steam in the main pipe, there must be condensation in the bent feeder, and the water of condensation must collect, in large measure, in the lowest part of the feeder, near the stop valve. Some changes had been made in the steam plant where this accident occurred, and the valve was being opened for the first time. Two men were engaged in opening the valve, from which it may be inferred that it was not found to work entirely satisfactorily. Moreover, there was a difference in pressure of 30 pounds between the boiler and the steam main, the pressure in the main being 150 pounds, and that in the boiler 120 pounds. A boiler should never, under any circumstances whatever, be "cut in" with other boilers until the pressure within it is practically identical with that in the steam main; because, if this condition is violated, there is grave danger of the rupture of some part of the structure, owing to the suddenness with which the stresses are changed when the valve is opened. In the present case, water had collected in the lower part of the bent feeder, and when the valve was opened this water was thrown against the valve with such violence that the casing of the valve was fractured, the arch cap of the valve being broken away from the body of the chamber, and the valve disk, stem and part of the arch being blown up through the roof of the building. The casing of the valve was ⅝ inch thick, and subsequent examination showed that it contained a small blow-hole, though this defect was too trifling to affect the strength of the casing to any serious extent. Two men were seriously injured by this accident, one of them losing his eyesight entirely, while the other one lost one eye. The dotted lines in Fig. 5 show the ideal way in which this steam feeder should have been run, in order to avoid entrapped water. If it was necessary to bend the feeder, however, in order to avoid the fore-and-aft line of pipe referred to above, the feeder should have been bent in such a way that its highest part should come next to the boiler,

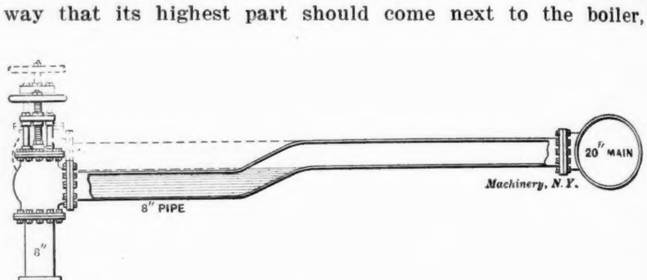


Fig. 5.

instead of next to the steam main; the riser being correspondingly lengthened. There would then be no pocket in which water could collect, and the feeder would have drained itself into the steam main.

A steam line should never be arranged so that it can possibly entrap water. If there is any doubt about the perfect drainage in any particular case, drip pipes should be provided so that the doubtful part can be thoroughly drained before steam is turned into it; but it should always be remembered that any pipe whose safe condition depends upon opening of a drip, as a distinct operation to be performed before the valve is opened, must be regarded as an element of weakness about the plant. Steam valves, under all circumstances, should be opened and closed very slowly, and when a pipe contains more than one valve they should all be eased from their seats slightly for some moments, so as to permit of the establishment of a certain amount of circulation, before they are opened up fully. By attending to these various precautions, it should be quite possible to avoid, in large measure, the serious accidents that are continually occurring in connection with pipe lines, and which are attributable to water hammer action, or to other analogous causes.

CONDENSATION FALLACIES AND FACTS.

Mr. W. H. Booth, in Electrical Review, June 17, 1904, p. 983.

The excellence of a vacuum appears to be considered too much as a matter of the quantity of water sent through the condenser, if this is of the surface variety. This is because

the arrangement of a surface condenser is usually of an entirely promiscuous nature. A surface condenser has a large number of tubes, all equally supplied with water, and steam flows across these tubes equally in contact with their colder and warmer extremities. It would appear more rational to enclose the middle length of the tubes in a jacket fitting closely round the bundle of tubes, and compel the steam to effect an entrance to the bundle and travel longitudinally along the spaces between the tubes, emerging at the other end by a very much narrower uncovered band to the air pump. The water should flow along the tubes in a direction counter to the flow of the steam outside them.

The amount of water necessary for condensing a pound of steam can be calculated very simply and directly. Assuming that the water has a temperature of 50 degrees F., and that it is desired to leave at 105 degrees F., there is a gain of 55 degrees F., or a trifle above 55 thermal units per pound.

The steam contains about 1178 thermal units per pound, and if it leaves as water at 55 degrees F., it loses 1,123 units. Then 1,123 ÷ 55 is nearly 21. Therefore, with a properly designed condenser, the conditions named demand only twenty-one times the feed for condensation. If the passage to the air pump along which the air flows could be made to traverse tubes filled with the water flowing to the condenser, the bulk of the air might be reduced, and the vacuum improved somewhat. This supposes the dry air pump, or a separation between the water discharge and the air discharge. The excellence of a vacuum ought to be determined by the temperature of the effluent water, and this, in a counter-current condenser, should be a little warmer than the entering circulation water.

Ordinarily the condensed steam is as hot as, or hotter than, the circulation discharge. Thus, instead of 55 degrees F., it would have a temperature of 105 degrees F. The relative vacua at these two temperatures are 29½ and 27½, a difference of 2 inches, or 0.86 pound pressure. The temperature of the water marks the limit of the vacuum that can be obtained, but it is very doubtful, under even the best practicable conditions, if so good a vacuum as 29½ can be got. The air in the condenser, like any other gas, has a volume proportionate to the absolute pressure reciprocal. At 27½ inches vacuum, the absolute pressure is 1.189 pounds per square inch. At 29½ inches it is only 0.207 pound. The volume is thus nearly sixfold, and to maintain such a vacuum, the volume generated by the air pump would need to be multiplied by six.

This is, of course, the reason why the Parsons turbine condenser is fitted with a steam jet, the object of which is to gather air at extreme tenuity, and force it toward the air pump at a somewhat greater density, in order that the air pump may bite off a greater weight per stroke than it can when only drawing on an air space at 29½ inches vacuum. Let us see what is the relation between air and air pump. Each cubic inch of free air, or atmospheric air, which gets into the boiler or the engine, or the exhaust pipe, expands to seventy times its volume at 29½ inches vacuum. Reduced to air-pump dimensions, this means that an air pump, 13½ inches diameter, with a stroke of 1 foot, would only deal with about 25 cubic inches of air, or about two-thirds of a pint measure, whereas the same pump on a 27½-inch vacuum would deal with one-half gallon. It is to reduce this one-half gallon into two-thirds of a pint that a steam jet is employed. Its effective pressure to do this must be such as to overcome a resistance of one pound per square inch. It is not to be overlooked that this steam jet must be at once killed, or it would spread back into the vacuous space and vitiate the intensity of the vacuum. An air-pump bucket can only extract at each stroke its own generated volume of air, and this must be greater than the volume to which all the inleaking air expands. If this be not the case, the vacuum will fall off until the air density is so much greater that the pump can get hold of as much weight per stroke as leaks in during a stroke period. A very small difference of vacuum makes a very great difference in the capacity of the air pump to deal with it. The repeated use of the same feed water should cause very little air to find its way into boilers, and air, in a condenser, is in such cases almost wholly a matter of leakage at glands. Better vacua years ago were obtained than are usual to-day. One reason was the use of fibrous packings on low-pressure glands, and there is nothing to-day to prevent the same being employed on low-pressure or vacuum glands, for these are no hotter than they were when steam of 30 pounds pressure was let into the cylinder. Another cause of air leakage is the long exhaust pipe to the condenser, carelessly jointed, and there are leakages through the valves which shut off the exhaust branches of each engine, not to mention other sources of air. These faults are what render the independent condensing plant so unsatisfactory in practice, because, instead of hunting up air leakages, the air pump is over-driven to conceal them.

The steam intensifier of the Parsons condenser is really a form of compound compressor, the steam jet representing the first cylinder of the compressor, and the ordinary pump representing the second cylinder. The whole combination is, of course, simply an air compressor, compressing to one atmosphere. The steam jet takes the place of the extra large first cylinders which it is necessary to use on the Rand, where the air at 6,000 feet elevation is of too low a density to provide weight sufficient in the ordinary sizes of machine used nearer sea level.

In a condenser the water demands a low temperature, or it will produce vapor to choke the air pump, and the air demands a large air pump to deal with it at high vacua. Hence the need for counter-current condensers for one purpose, and supplementary air condensers to cope with highly-expanded air.

INTERNAL COMBUSTION ENGINES AND THE DIESEL PRINCIPLE.

Mr. W. H. Booth, in Electrical Review, June 10, 1904, p. 975.

It has been pretty conclusively shown that economy in the gas engine attends on high compression, but practice has shown equally conclusively that high compression of an explosive mixture has a low safe limit. The compression of a gas requires the expenditure of energy, and this energy in the case of a perfect gas is converted entirely into heat energy, and manifests itself by rise of temperature. In a slowly running engine much of this heat could and would pass into the water jacket, and so far would be lost for useful work in the engine. Compressed quickly as it must be in any engine of moderate size per unit of effort, the gaseous mixture becomes heated to a high temperature, and becomes spontaneously explosive. Myself, I have little doubt that spontaneous ignition takes place more readily in the more highly hydrogenous mixtures, and this very real danger shuts out from high compression use the richer gases; and those with much hydrogen in their composition, such as the water gases and the coal gases, are unsuitable to be employed in high-compression engines. Mr. Thwaite, in his blast-furnace gas practice, has found that the very poor gas produced from a blast furnace, and containing very little hydrogen, is a very manageable gas. This may partly be due to its considerable constituent of carbon dioxide, which assists to delay ignition. Suffice it to say, that blast-furnace gas will safely endure an intensity of compression above what can be secured with richer and hydrogenous gas.

Now, in the Diesel engine, compression is entirely independent of the quality of the fuel, for the very simple reason that no fuel is introduced until it is wanted to ignite. Pure air alone is compressed, and therefore the intensity of compression is limited only by two factors—the ability of the mechanical construction to withstand the stresses, and the thermal possibilities involved. The high compression produces a temperature sufficient to cause ignition of the fuel, and this ignition takes place as soon as the fuel is introduced to the heated atmosphere in which it burns.

Thus the Diesel engine does act along very different lines from those casual lines of the ordinary internal combustion motor. Though the full cycle intended to be worked by Diesel has not been found practicable, a part of it has been secured, and combustion takes place on isothermal lines, the diagram of the Diesel engine being simply the compression

curve pushed forward by temperature, so that the air occupies a larger volume at the same pressure. Thermally, the advantage of this system is that the maximum pressure may be employed that the machinery will permit, and there can be no pre-ignition. There is no sudden accession of pressure on the dead point, but the pressure may even rise a little after the crank has passed its position of zero effort. In this way there is less mechanical loss incurred through the imposition of a heavy pressure on the bearings during the time such pressure is producing no turning effort. Where early ignition takes place and produces this effect, much of the heat is passed directly to the water jacket, and therefore wasted. In gas and oil engine work it is of importance that the heat generated by combustion should pass very directly into mechanical work. Every engine is, of course, a compromise between full ignition on the dead point and the longest utilization of the pressure produced, and prolonged combustion, with a minimum of loss to the jacket. Early and complete ignition not only produces frictional loss, but jacket loss. These losses are both saved by prolonged combustion, which, by purely academic men, is looked on as an error. Hence the importance of securing a satisfactory compromise. In the Diesel system this compromise, combined with the principle involved, enables an efficiency to be obtained as between indicated horse power and calorific capacity of the fuel of 42, if not 44 per cent., and well over 30 per cent. can safely be counted on, referred to brake horse power.

As a machine, the Diesel or other engine may be fully as frictionless as a steam engine, and recent tests of a Diesel engine have shown me that this is the case. I have also found that an indicated horse power hour can be got for about 0.32 pound of crude oil with a calorific capacity of about 19,000 B. T. U., and this points to a very efficient utilization of the heat value of the fuel. This high efficiency is a result due largely, of course, to the high compression which is possible only with the Diesel system of fuel admission. It is also partly due to the diminished friction and diminished jacket losses referred to, and these advantages may be more or less secured in other forms of engines than the Diesel.

The future improvement of internal combustion engines lies so much along the lines followed by Diesel that this motor may be studied to good advantage, for its system of compression removes the most serious limitations of the ordinary engine, and in weight of combustible per unit of energy output its record is far ahead of any other motor.

* * *

HOW CAR INSPECTORS ARE BEATEN.

A writer in the *Railroad Gazette*, who formerly was a car builder, throws a vivid light on some shady practices followed in car building shops when orders are taken on too close margin or the specifications are considered by the management to be somewhat too rigid. Perhaps equally as interesting tales could be told regarding the execution of certain supposed high-grade machinery if the perpetrators thereof were disposed to take the public into their confidence. The writer says:

"I remember when I was foreman of a shop in an Illinois town some years ago, before the advent of steel body and truck bolsters, we got a job that called for white oak bolsters. White oak was rather scarce and hard to get at any price, but it chanced that the shop was adjacent to a scrub oak country and that there were plenty of saw mills to supply the demand, so the superintendent decided to saw his white oak bolsters from scrub oak logs, securing thereby a much cheaper article and a much longer time on his bills. But the inspector whom the railroad sent out was wise on white oak, and the superintendent knew that the scrub oak has a peculiar smell which would distinguish it readily from the real article. The sample car was put up with white oak, as specified, and, in the meantime, the home product was cut and run to size as rapidly as possible, and was stacked up to dry in "the shade." Enough was run in this way to fill the entire contract. While this was going on, some fresh, recently cut white oak was procured and run through the planer. The chips were carefully collected and a decoction of white oak was brewed in a large iron kettle. Then we took a whitewash brush and gave the scrub oak bolsters a good smear of our special brewed white oak perfumery, and completed the job by painting the ends with mineral paint. The two together effectually killed the barn lot smell of the scrub oak. When the inspector came around he demurred at the dark appearance of the wood, but it was explained to him that it had lain out in the weather and was rain soaked. He passed our home-industry bolsters without a murmur.

"After the iron bolsters came into use it took a slightly different style of treatment to doctor them, but there were ways. Once the company by which I was employed had to turn out a thousand truck bolsters for another firm that was caught short on a contract. The understanding was that the other firm was to furnish the material and we were to do the work. The superintendent and I figured long and earnestly as a committee on ways and means, for our shop had never attempted anything like it before. There was an abundance of drilling and riveting to be done and no labor-saving appliances to do it. He finally decided that he would do it any way, and put on a night shift, as we got a pretty stiff price for the work. The bolster company sent an inspector down, who proved to be a terror, and we had to do most of the night shift work over again in the daytime, as they only got about one rivet out of ten tight. The inspector was always on the spot and every loose rivet had to be cut out and replaced by a tight one. Our night shift was recruited from around town and the surrounding country, and each of the boys was perfectly competent to follow along behind a mule, after the reins were around his waist so that the motive power would move man and plow together. They could haul logs, too, with a pair of steers at about one mile per hour, but when it became necessary to move up a peg and get a hot rivet down before the shrink was all out of it, the spurt lasted just one rivet, and that was all. Between the night shift, the superintendent, and the inspector, I had gotten to the stage where if any one so much as asked what time it was, I would tell him to cut it out and put in a new one, my mind being wholly on loose rivets.

"Finally, we got a new foreman for the night gang, and the new foreman sized up the situation and asked me to have a calker made. After that, we finished up the edges of our loose rivets with a good sharp calking tool, and when the inspector tested the plates, they sounded as tight and solid as if they were made out of one piece. The superintendent saw that it would not do to get perfect work all at once, so we left the inspector a few loose rivets now and then for the next week or so, but finally tightened them up to the satisfaction of all concerned. Out of that one thousand bolsters, I don't believe one hundred went out perfect, for there really did not seem to be any use in driving rivets tight when you could fix them up with the calker.

"When it comes to beating the inspector on castings, you have to get at it in a little different way, as castings have to turn out the way the patterns make them. A simple and effective way to get around this is to have a double set of patterns, with a private mark on each so that if you really want to you can tell which is which. This will save you maybe 10 or 12 dollars' worth of pig iron on each car, which would help keep the officers of the company in cigars and pay for an occasional watch or gold-headed cane if the inspector ever should happen to tumble on a short weight. When the inspector first arrives on the scene, with his mind full of responsibility and a disposition to test everything in sight, he finds a nice little stock of standard castings waiting for him. Maybe 25 cars of castings of all kinds are gotten out while he is familiarizing himself with the patterns and breaking a few wheels to test them for hammer blows and depth of chill. The scales are wheeled up to the piles, so that they can be weighed, the inspector pronounces his O. K., or suggests the desired changes, and then when he gets through we begin making green goods for him by exchanging patterns that make castings from eight ounces to ten pounds light, always keeping on hand a few of the right weight for emergencies."

SOME MICROMETER MEASURING INSTRUMENTS.

A. L. MONRAD.

Having lately received letters from several persons inquiring about a combination micrometer I will endeavor to describe one of my own design, that I believe to be suitable for all classes of work. Fig. 1 shows an assembled view and the details of a 5-inch surface gage, which can be used as a height gage in obtaining the heights of projections from a surface, in locating bushings in jigs and work of various kinds. It is preferable to the vernier or slide caliper, now in use, because the different settings can be made more quickly and positively and for the readiness with which the graduations are discerned. It is also more convenient to handle in every respect.

The jaw projects beyond the base, is hardened and accurately ground for parallelism. One end is beveled and ground to an edge for use in scribing lines upon work. It has a 40 pitch, to a turning fit in the thimble *f*, and the adjusting nut *d* to compensate for wear.

On the same end a groove is milled 1-16 inch wide and 3-32 inch deep, that serves as a keyway for the pin *j*, which holds it in position and prevents it from turning. The barrel *b* is made of tool steel with a ¼ inch hole through the entire length. This must fit very nicely on the rod. It is graduated by a series of five annular grooves, 1 inch apart, that are of such form and depth that the clamping fingers at the end of part *h* when sprung in will fit accurately, thereby allowing the setting of the rod by inches to be quickly and positively made. There is also a 1-16 inch half round groove, planed its entire length on one side to fit the key *k*. The lower end is beveled so that the graduations on the rod are readily discerned. At the other end it is nicked down 3-32 inch, and ¼ inch wide to fit the bushing *e*, and this end is hardened and lapped to a true surface. Bushing *e* is made of tool steel, with a sharp groove filed in a little on each side, and has a taper .010 to 1 inch, to fit the mouth of the thimble. After it has been hardened, ground, and lapped all over to a plug fit in the barrel, and with a driving fit on the thimble, break it apart so it can be placed in position when assembling. One end of the thimble is bored to fit the barrel, and at the bottom of this hole is threaded to receive the adjusting nut *d*. It is then placed on an arbor which has been turned in a chuck, and the center hole bored out, threaded to fit the rod, and chamfered out at the end to within 3-16 inch of the threaded part. The outside is shaped like an ordinary thimble with a graduation of 25 divisions. Speeder *g* has a tight fit in the thimble, and is turned down to ⅛ inch diameter, and milled its length by a 60 degree cutter. This gives a good grip and allows the thimble to be turned quickly.

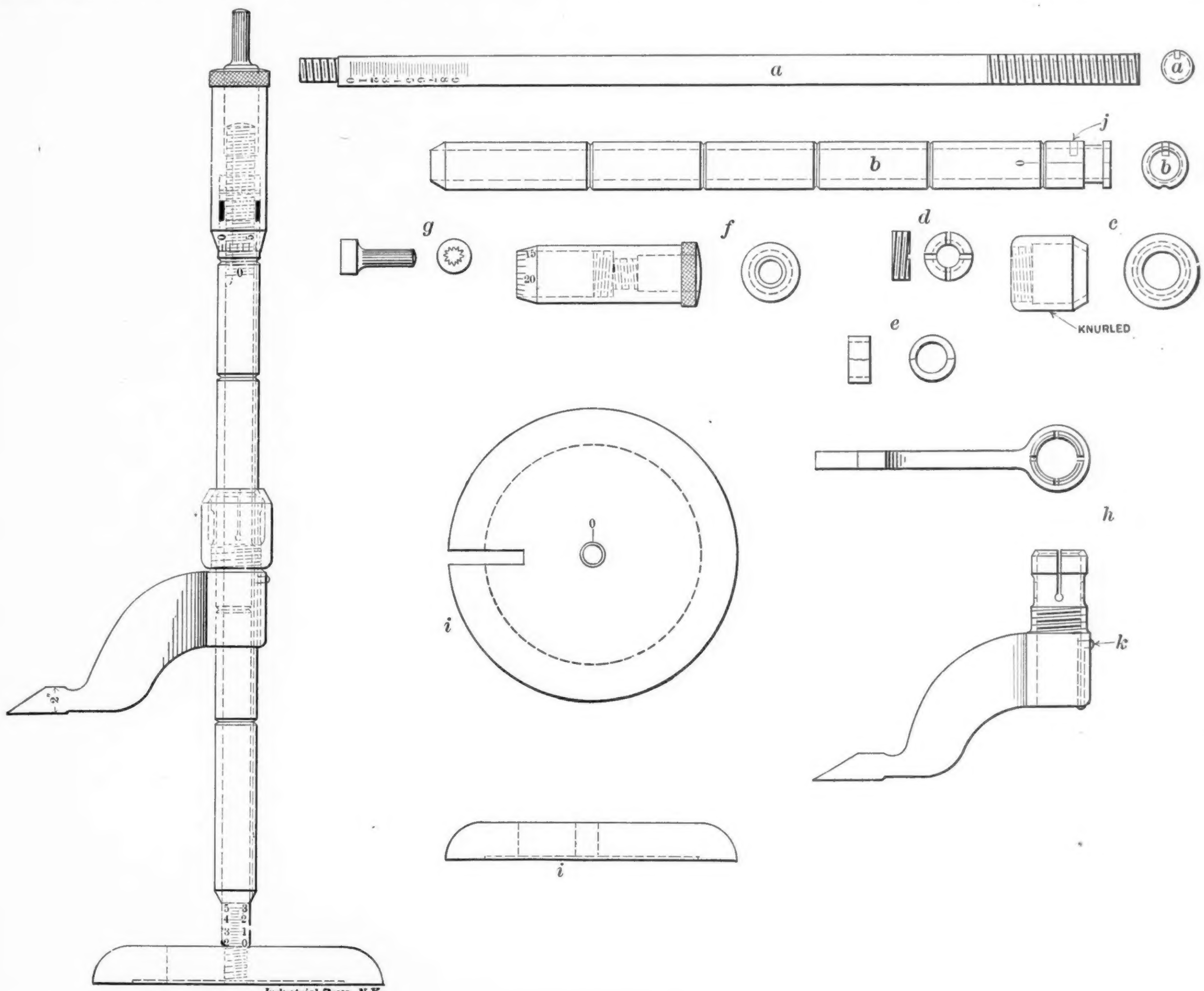


Fig 1. Assembled View and Details of 5-inch Micrometer Surface Gage. The Spindle and Micrometer parts are used in other Combinations shown in the following Views.

range, by thousandths, from zero to 5 inches, and all fractions of an inch are obtained by means of the micrometer screw. Rod *a* is made of tool steel ¼ inch diameter and 7.5 inches long. At the lower end it is threaded 40 pitch to receive the base *i*. There are 40 divisions graduated on the lower end of the rod, each division being .025 inch wide. On the right are the figures for measurements from the surface to the point of the scriber, and on the left those for measurements from the faceplate to the top of the scriber, which may be used to set a tool to a certain distance, or to measure under a shoulder. (See assembled view.) The other end of the rod is threaded

The main body of the instrument, *h*, is made of tool steel. The lower end of the round portion is bored out in the center

A. L. MONRAD was born in Christiania, Norway, June 23, 1868. He received a high-school education and took a course in the Christiania College of Technology. His apprenticeship was served with the Winchester Repeating Arms Co., New Haven, Conn., and he has since worked for the Burgess Gun Co., Buffalo, N. Y., Colt's Repeating Fire Arms Co., Hartford, Conn., Lozier Mfg. Co., Toledo, O., and others. He served as foreman for two concerns. His specialties are gun work, designing and model work. Since coming to America in 1885 Mr. Monrad has acquired an experience equaled by few.

so that the scriber will slide freely, but will have a good fit on the barrel. The upper end is formed into a split chuck, spring-tempered, which grips the barrel and holds it in position, while the lower part is threaded to receive the knurled cap *c*. This tightens the split chuck and serves to hold the part firmly in position on the barrel. In the lower end is fitted a round key *k* 1-16 inch diameter with the end bent at a right angle, whose purpose is to prevent the scriber from turning on the barrel. The point of the scriber is hardened and the upper and lower surfaces are parallel 0.2 inch apart. The cap *c* is made of mild steel, casehardened, knurled its entire

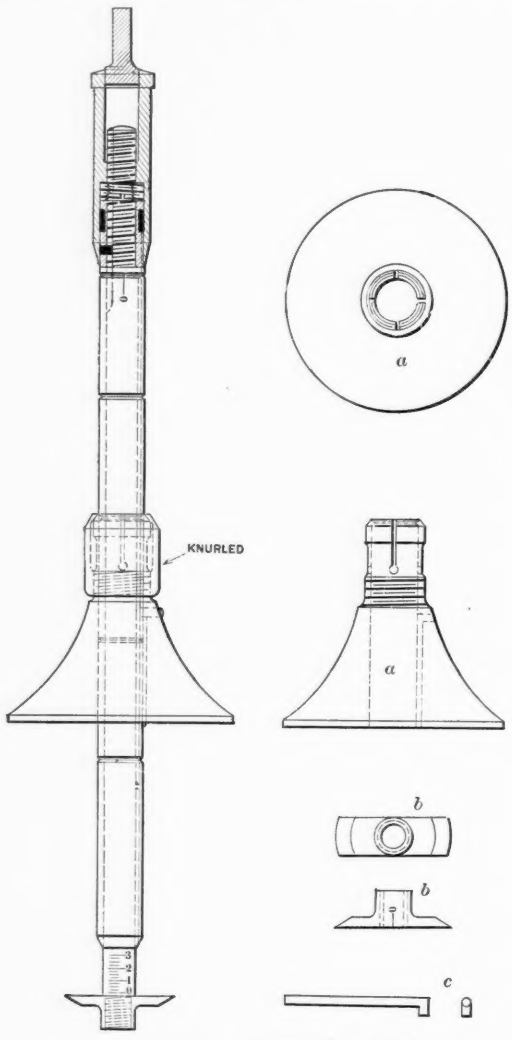


Fig. 2. Micrometer Tool used as a Scratch Gage.

length on the outside, and fits the scriber chuck. The base block *i* is made of mild steel casehardened, and lapped at the surface. In the center it is tapped for 40 pitch thread to fit the rod, having a zero line to place it in the right position, and through the forward part of the block is a slot that allows the measuring or scribing jaw to come flush with the bottom of the base.

When ready to assemble the adjustment is very simple. Draw the zero line from the end ⅝ inch down on the barrel. When the tool is set to measure 1 inch correctly, draw the thimble over the split bushing, starting with the zero line at the end and continuing until in position.

Fig. 2 shows the same tool used as a scratch gage, which may be done by changing two pieces, and in this form will be found very convenient on a job that cannot be handled with a surface gage. This simple device has saved a lot of time, when accurate scratch line is wanted, where other means had to be applied. In addition it can be used as a depth gage, by exchanging the scriber *b* for the shoe *a*, shown in Fig. 8. The scriber *b* is made of tool steel, hardened and ground on each side to an angle of 60 degrees, and may always be set in the right position by drawing it to the zero line. The base *a* is made of tool steel and the top end forms a spring-tempered split chuck, using the cap *c*, shown in Fig. 1. The key *c* is made of 1-16 inch round Stubbs wire and bent at an angle of 90 degrees to fit the base.

Fig. 3 shows a 5-inch special, or disk micrometer which has proved very handy in measuring snap gages, slots, and thicknesses, and which may also be used as a height gage to ascertain the distance from a shoulder to the base. In measuring slots the outer sides of the disks are used and for thickness the inner sides. This form may also be used for setting tools on a planer or shaper. As shown in the cut, there are two sets of graduations on the rod, which enables the operator to see at a glance the measurement recorded either from the

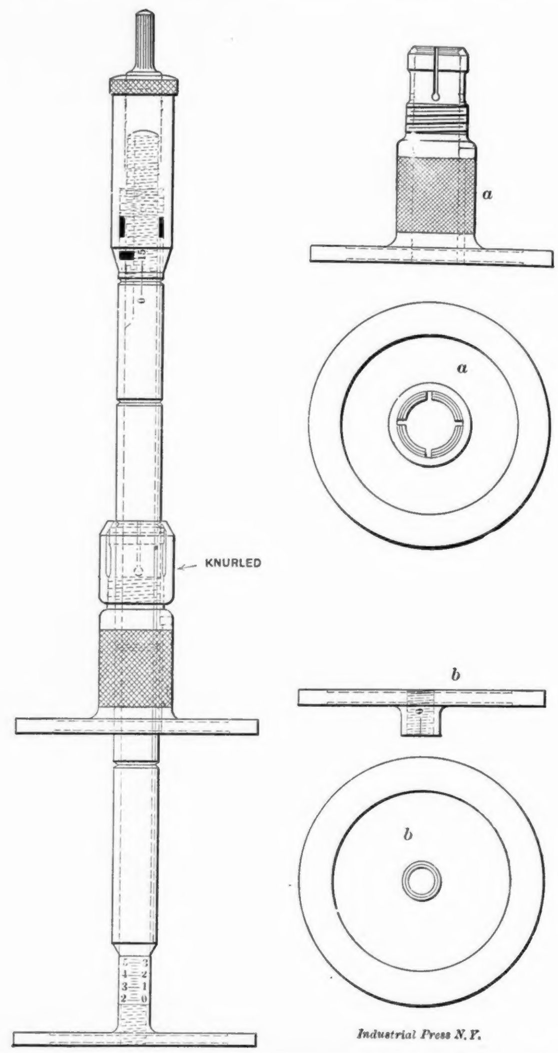


Fig. 3. Micrometer with Disk Attachments in place of the usual Jaws.

inside or outside of the measuring disks. Each of the disks is 0.10 inch thick, so that the range of the micrometers is .400 inch for inside when .600 inch for the outside.

The disk *a* is made 2 inches in diameter and disk part is hardened, ground, and lapped. Great care must be exercised in lapping so as to make it perfectly true and parallel. The upper end is spring-tempered and fitted to the cap described for the first form. Disk *b* is hardened, ground and lapped, fitted to the rod in the usual manner, and screwed to the zero line.

By use of the parts shown in Fig. 4 we have a 5-inch micrometer caliper square which is preferable to the vernier caliper. It has the great advantage over the vernier, that the reading may be readily discerned without straining the eyes, and the use of a magnifying glass is avoided. Its manipulation is as easy as that of a regular micrometer.

The jaw *a* is fitted to the rod in the usual way to zero line, and the end is hardened and lapped to a finish surface. The jaw *b* is made in a similar manner, and knurled in the middle for a grip, the top end being fitted to the knurled cap. This forms a very neat and light tool; but it must be carefully and accurately made to be of value.

Fig. 8 shows a 5-inch micrometer lathe stop, which is one of the most accurate and universal tools in use. How difficult

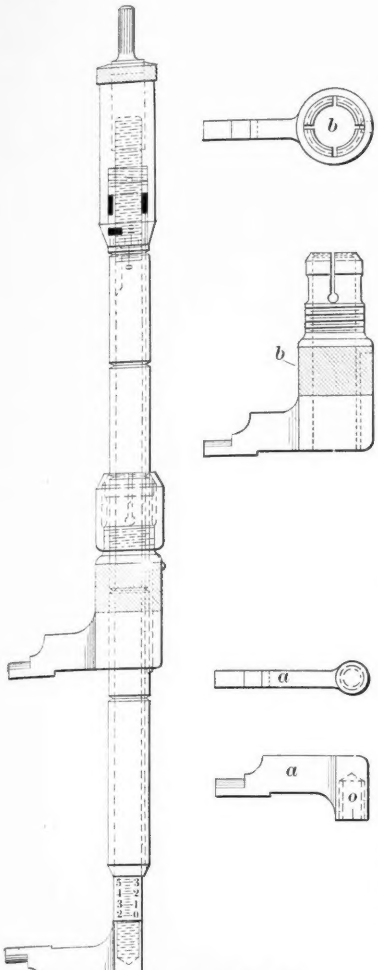


Fig. 4. Five-inch Micrometer Square.

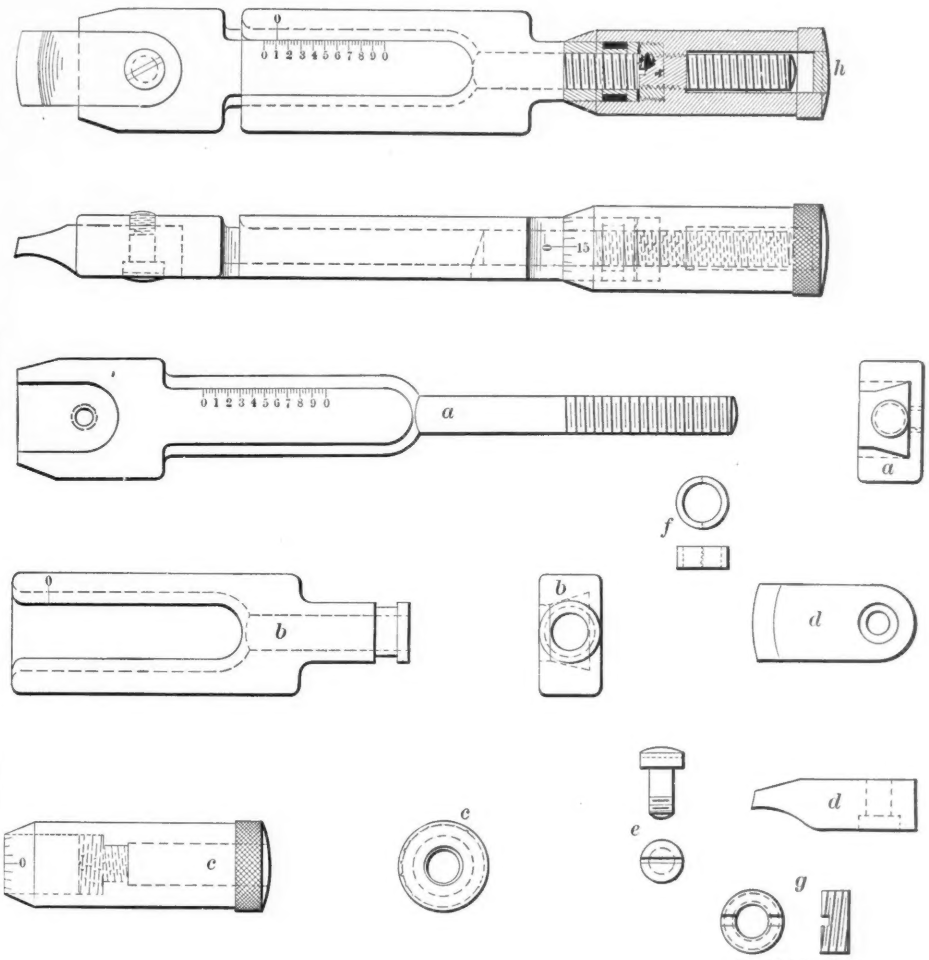


Fig. 5. Micrometer Lathe Tool.

it often is to gage correctly a certain piece of work in the lathe or planer, especially when a distance of several inches is required, and frequently it becomes necessary to make a template or a length gage in order to get any halfway decent result. This tool "fills the bill" and does away with the "cut and try business." It can be used on either the right or left side and the holder is of so rigid a form that it does not show

wrench fitting in the hole c. Thus we have five very handy tools almost combined in one, only slight changes being required. They save a lot of labor and do not take up so much room in the tool chest, where there is usually insufficient space.

Fig. 5 shows a micrometer finishing tool for lathe or planer. Most of the modern machines are supplied with a micrometer

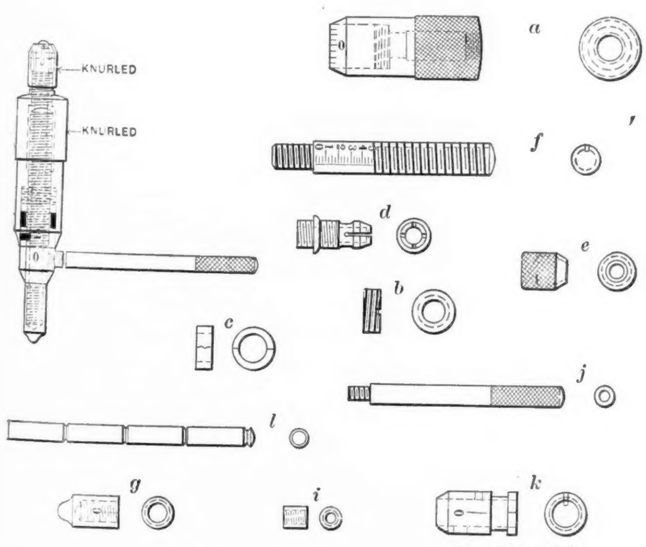


Fig. 6. Small Inside Micrometer.

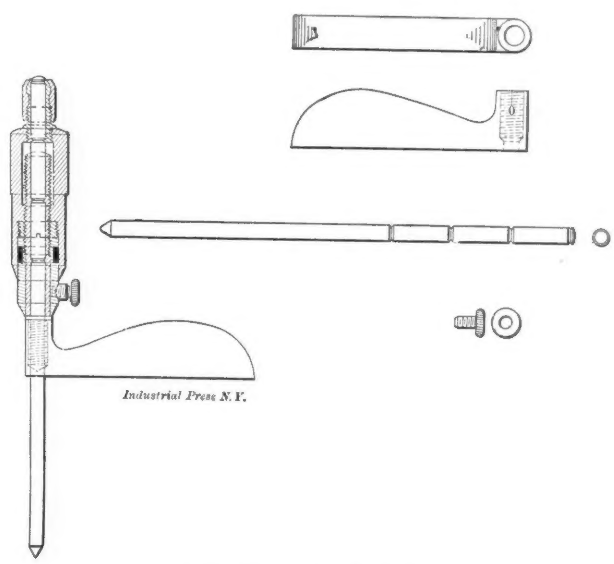


Fig. 7. Micrometer Depth Gage.

the tendency to spring, that is a serious fault with some. It is made to fit any machine of modern make, being clamped either on the rib or the flat surface.

The C-shaped clamp *b* is beveled a little on the inside, for convenience in adjusting in place on the machine and on the side is formed the usual spring chuck which fits the cap before described. On the end of the rod is fitted the shoe *a*, hardened and lapped, and drawn to the zero line by a spanner

screw stop, but the old ones are not, and on such this tool will come handy. It is designed on the same principle as the others, and the tool points are interchangeable. By making them fit snugly on the sides, the screw *e* will hold them firmly in position.

Part *a* is the main body of the tool. On the end a 40 pitch thread is cut to fit the thimble, and the sides are dovetailed to fit the holder *b*. Near the middle of one side one inch of

space is graduated, the lines being .025 inch apart. On the other end is a recess with a tapped hole to secure the tool *d*. The holder *b* a sliding fit in *a*, and on one end is the zero mark, while the other is nicked down to receive the split bushing *f*. The thimble is made in the usual manner as also the adjusting nut *g*.

Fig. 6 shows a neat little inside micrometer, designed for internal and lineal measurements. It is useful for measuring cylinders, and rings, etc., as well as for setting calipers, comparing gages and measuring parallel surfaces. The micrometer screw in the head has ½ inch movement, and the device is so designed as to be in touch with the other tools described above. The thimble *a* is constructed in the usual way, except that the top is fitted to receive the spring-chuck *d*. The adjusting nut *b* is made in the usual manner to compensate for wear, and the split bushing *c* as before described. On the thimble is screwed the tempered split chuck *d*, with the

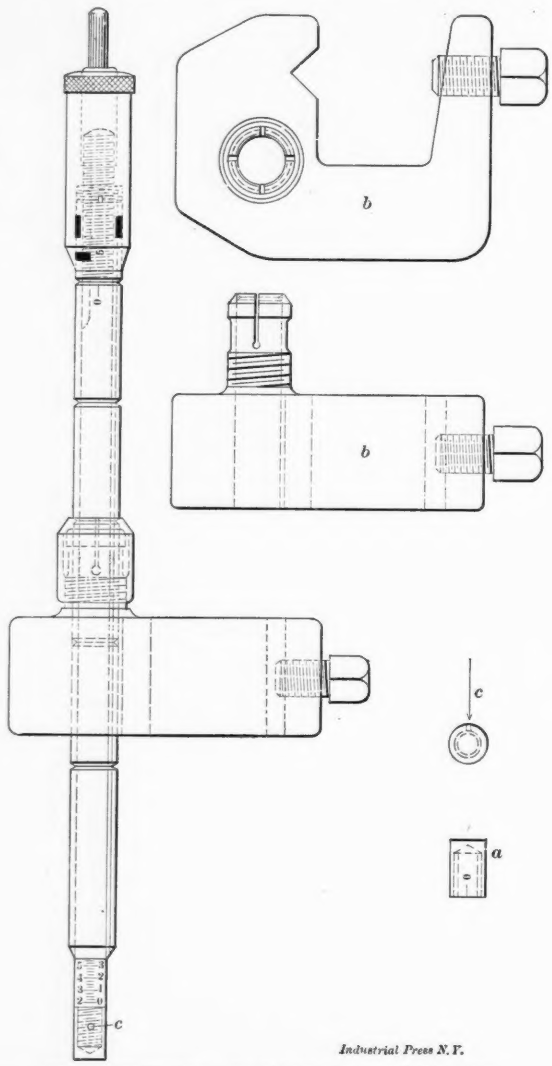


Fig. 8. Micrometer adapted for use as a Lathe Stop.

knurled cap *e* to clamp the rod in position. On the lower end of the screw *f* is fitted a shoe *g* which is shaped at the point like the rod. On the barrel *k* is soldered a bushing *i* which is tapped inside to receive the handle, thereby enabling one to take measurements in holes and other places where the micrometer could not otherwise be used. This handle may be exchanged for a thumbscrew, which may be used to lock the instrument after a measurement has been taken. Rods like that shown at *l* may be made of varying lengths.

Fig. 7 shows an instrument designed for measuring the depth of holes, grooves, or recessed parts, as well as gaging under a shoulder, or measuring the height of a small projection on a plane surface. The gage screw has a movement of ½ inch, and is encased and thus protected from dirt or injury. The measuring rod is graduated by a series of annular grooves ½ inch apart. The parts are the same as before and it is only necessary to unscrew the shoe, and replace with the base. Fig. 7, made in such a shape that it can be used in close shoulder work. This tool can be used as disk-gage, surface-gage, height-gage, etc., by placing the different parts in the split chuck and the machinist's needs may suggest various other uses to which these devices by slight changes may be made to apply.

* * *

THE DAVIS SELF-LOCKING CAM.

In the usual construction of mining stamps, used for crushing ore, the stamps are operated by double cams mounted upon a longitudinal horizontal shaft. These cams are made to give a free fall to the stamps, and are arranged on the shaft so that some are always lifting stamps while other stamps are falling, the reason, of course, being to equalize the driving power. Because of the shock and vibration it has been found very difficult, if not impossible, to keep these cams tight upon the driving shaft with any ordinary system of keying. Moreover, it is highly desirable that the cam can be easily removed as they wear out comparatively quickly and so have to be periodically renewed. For these reasons self-locking cams have found favor, the Blanton type being well-known. This is somewhat expensive in construction as special machinery is required to machine the locking surfaces which consist of a series of arcs arranged in sawtooth fashion. In the Davis self-locking cam, however, the construction is simpler.

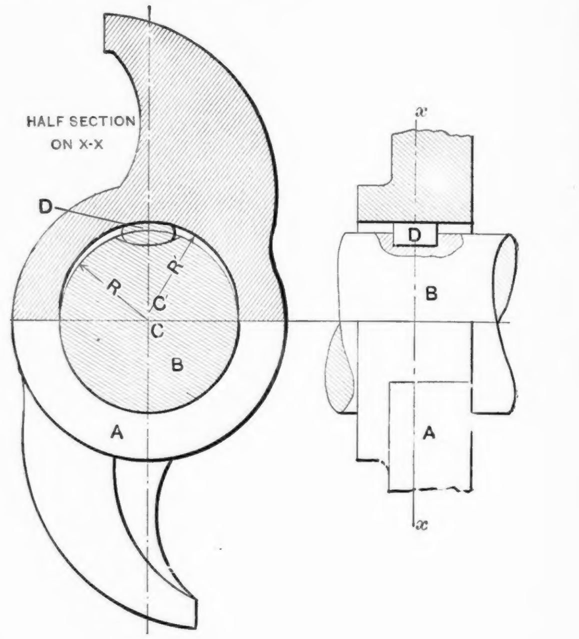


Fig. 1 Fig. 2.
Cam for Stamp Mills.

Referring to Figs. 1 and 2 which show side and end views with sections in each case, *A* is the cam, which, it will be observed, is double, that is, it lifts the stamp twice in a revolution; *B* is the shaft; and *D* is the key. After the cam has been bored to the radius *R*, it is set over and with the same radius an eccentric seat is bored in the middle of the bore and having a width about one-half that of the total length of the bore. This eccentric bore is shown in Fig. 1 by the radius *R'* drawn from the eccentric center *C'* and its width is indicated by the length of key in Fig. 2. A keyway is then cut through the bore somewhat wider than the key, and it is cut so that its bottom conforms to the arc of the eccentric bore. The key-seat in the shaft is milled with a cutter of the same radius as the shaft, and the key is made with its two working sides shaped to the common radius *R*. In assembling, the key is seated in the shaft and the cam is shoved on until the eccentric bore is directly over it; then a backward turn locks the cam on the shaft so that it can neither turn on the shaft nor slip endways. If the degree of eccentricity of the bore *R'* is correctly chosen the cam can be easily loosened by a blow on the point in the reverse direction.

* * *

An important ordinance has been passed by the Board of Aldermen of New York City, and is now in the Mayor's hands, requiring the use of fireproof wood in all buildings over 75 ft. in height and in all public buildings over 35 ft. in height.

LETTERS UPON PRACTICAL SUBJECTS.

A VACATION AND WHAT CAME OF IT.

Editor MACHINERY:

A friend of mine was telling me a while ago how he spent his vacation, and it was so interesting that I think that it will stand relating.

He was a toolmaker and he had worked steadily for over a year, and at the same time was taking a correspondence course in mechanical drawing. The hot weather was coming on and one night he came home and said to his roommate: "Bill, let's take a vacation." "Done," said Bill. "Where will we go?" "Denver," said Ed. "All right," replied Bill. And the next morning they "jacked up" their jobs, bought a first-class ticket for Denver and started.

They enjoyed the trip and arrived in Denver and took a room at a good hotel and the next morning started out to do the town. Ed. got a job at once in a small shop on the outskirts of the city engaged in tool and experimental work. His first job was making a die for a shoe heel. He had worked on the job about two or three days and was getting along first rate except he was handicapped for the want of tools, especially files. Ed. was working away using the stub end of a file next to the handle, which was the only place which had any cut left, when the foreman came along and said: "I've had all sorts of men working for me, but I believe that of the whole lot, you're the awkwardest hand with a file that I ever saw." They had a few words over it and the outcome of it was that Ed. got fired.

He went home to the hotel and was mad clean through. He, an A1 toolmaker and one of the best vise hands in St. Louis, had got fired out of that little one-horse shop because he did not know how to handle a file! He was still "chewing the rag" over it when Bill came home and he told him the whole story, and said: "That's the last day's work that I'll do in a machine shop for one year, for if I ain't got it in me to do something higher. I'll get along without."

The next morning he started out and made a tour of the draughting rooms and civil engineers' offices, and finally struck a place with a mining engineer at draughting, working under instructions and with the understanding that it was to be a short job only. He stayed there two months and finished the job; when he left he was given an extra week's salary in consideration of the good services rendered.

The next day after leaving the mining engineer's office he bought a camping outfit, including a woolen and a rubber blanket, packed them on his back and started up the line of a new railroad in course of construction, the name of which I am sorry to say I have forgotten. He got a lift of thirty miles on a gravel train and fifteen miles more on "shank's mare" brought him up with the tracklayers. He found that they were full handed and there was no show for a job there; but that the engineer of the surveying party, some thirty miles further up had sent back word he needed some axmen. That night he stayed in camp and was used finely, had a good supper and a clean bunk and the next morning shouldered his sack and started on.

Fifteen miles was the best that he could do in that day and that night he slept in the open, with a log for a pillow and the moonshine for a blanket. Getting an early start the next morning he came up with the surveying party about noon. He found the chief engineer and applied for a job. The chief looked him over, smiled and said: "You're a tenderfoot all right, but if you think you can learn to swing an ax I can give you a chance to try; the pay will be $30 a month."

Now, Ed. had been brought up on a farm and if there was any tool outside of a machine shop that he could handle well, it was an ax. After dinner he was given a good ax and started in. There was a good-natured grin on the faces of the crowd as the tenderfoot came out, and the first good-sized tree they came to, the boss, a big French Canadian, said: "You take him 'one side,' and 'take him one side' he did, and when the tree was down the boss said: "You one good man; I tink you have seen ax before."

That night the engineer came around and said: "We need an assistant to the transit man, and in the morning you take hold with him; the pay will be $45 a month." The next morning he started in with the transit man running the cross levels. He stayed at this two months, learning, as he said, more about angles than he ever knew before. The weather, getting too cold for comfort, he "jacked up" the job and left the engineer with mutual regret, and promise of $60 a month if he saw fit to come back in the spring.

He came back to Denver, put in a week of sight seeing and then back to St. Louis, where he struck a job as draughtsman in a mechanical engineer's office, and when I saw him had been there over a year, coming in at 8 o'clock in the morning and going out at 5, drawing a weekly salary instead of "pay" and wearing a boiled shirt with case hardened ends.

"And now," said he, "I've proved to myself that I can make a living outside of the shop, and I'm going back into it again as soon as I see a good chance. I may stand at the desk instead of the bench, but I'm not afraid but that I can fill the bill in either place."

Should this tale, as told by him stimulate any of the boys to take another step up the ladder, this will not have been written in vain, and they will have the best wishes of

A. P. PRESS.

THE PRACTICAL PERSPECTIVE.

Editor MACHINERY:

It is pretty safe to say that anyone who has ever made a drawing has wished at times to be able to show a piece in perspective; perhaps only a detail or possibly a whole machine or building, but the artistic or "true perspective" takes too much time and patience for the average draftsman. Men in the shop often express the wish, in language of varying intensity, that the drawing was made "so you could see what the thing really looks like." This is probably why many men like to work to "samples" rather than drawings.

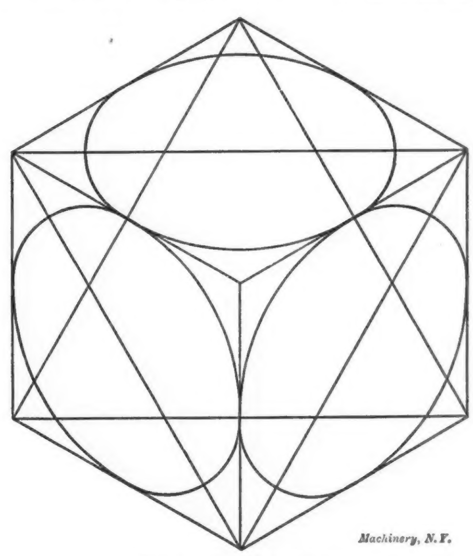


Fig. 1. Isometric Cube.

There seems to be only one practical way of using perspective, and that is what is called isometric projection. It was discovered or invented years ago, but has been about as hard to master as the true perspective and has not been made popular. In isometric projection lines which are normally horizontal are inclined 30 degrees from the horizontal in either direction, while vertical lines remain vertical. This makes a cube appear as a hexagon (see Fig. 1) and, as will be seen, makes the three visible sides "diamond" shape. These diamonds are the foundations for all circular work and as it is the circles which bother anyone in perspective drawing, a little attention to these will help make the matter clear.

All circles which lie in a horizontal plane and on which we look down when they are thrown into perspective, become ellipses in the upper diamond with the long axis horizontal. All circles or ends of shafts or tubes which run off to the left

have their ellipses in the right-hand diamond with the long axis, as shown. And all ends of round pieces which run off the right become ellipses in the left-hand diamonds. This holds true on all occasions and will help you out when you run up against something that seems hard to show or doesn't look quite right.

The wrench shown in Fig. 2 is an example of how often this works into sketches. With the handle going off to one side there is a great tendency to twist the ellipse around also—

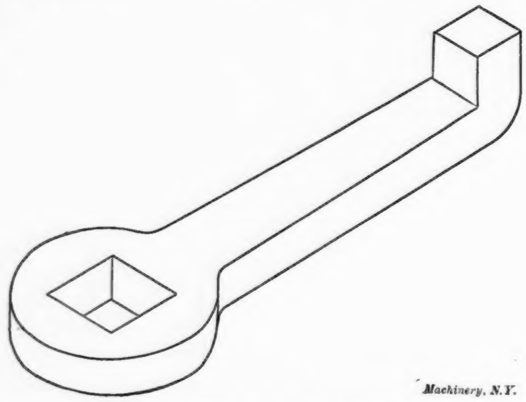


Fig. 2. Wrench in Isometric Projection.

seems as though it ought to be, but it is a top view and the ellipse remains as shown at the top of the square. To make this still more clear the spoked wheel in Fig. 3 is shown. Here the four spokes go in different directions but the central ellipse is horizontal just the same. This figure is made on a specially ruled paper so as to make it plain about the diamonds and to show how easy it is to draw with such guide lines. Where there are few curves the whole thing can be quickly done in freehand.

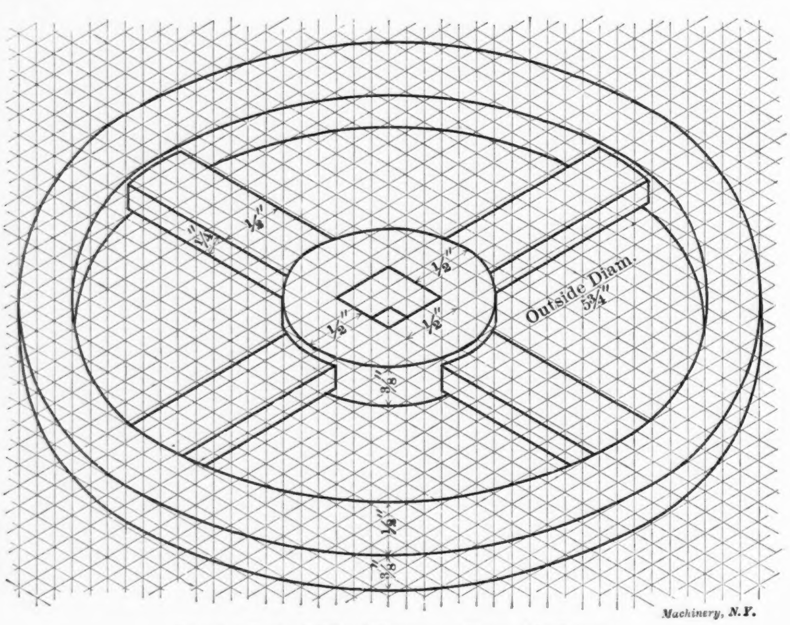


Fig. 3. Spoked Wheel Drawn on Isometric Paper.

Fig. 4 shows a rod end and gives an example of circles in the three positions. The broken end is in one position, the hole in the brass in a second, and the oil cup in a third. It might be thought that, as the rod is thrown up at an angle the oil cup circle should also be in that position, but such is not the case. A few trials will convince that this is right.

There is no question as to the value of this method for "assembly" drawings, even if details are made in the old way, but the details can be worked out in the same manner and are very easily understood. FRED H. COLVIN.

HIGH-SPEED STEEL IN THE MACHINE SHOP OF TO-DAY.

Editor MACHINERY:

This world is one of hustle and bustle, especially among us Americans. We are always looking around, trying to find a short cut to wealth. Now, how many of the manufacturing establishments of this country are really saving any money, in the way many of them handle the different brands of "high-speed steel"?

High speed steel has been before the manufacturing public for some time, but not until quite recently did it come into such general use and attract so much attention. It is, indeed, a great way to save money if handled by the people as it should be. It has great strength and can stand what no ordinary steel can stand. You can not pick up a mechanical journal to-day and not read of some of the marvels that have been accomplished with the "high speed steel." There is a great saving in time, but right here many close their eyes. Do they not save time at the expense of something more valuable by far? Right here starts the mistake.

A foreman in a machine shop will pick up a mechanical journal and read (if he reads one at all) of the great time saved by Blank Mfg. Co., of Somewhere. He will read it with amazement and perchance say to himself, "Well, now, is that possible? I will have to 'speed up' the men a little to keep in line with the rest of the world." He will come into the shop and start in on Tom. "Tom, throw that belt down on the high speed and put on a little heavier feed." So he will go around from one to the other. Then he struts around the shop with a self-satisfied grin on his face and tries to make the men feel that he is of some importance about the place. He thinks he has accomplished something of note. But has he? Did he, maybe, speed up his men more than their machines were capable of doing, and spoil the accuracy of the machine? Most of these tests are made on "high speed lathes," lathes that are especially constructed to stand the strain to which they are subjected. Lathes with long bearings, large driving belt, and heavy headstock spindle, and many other minor points that make them stronger than the average lathe. But you go into many shops and they are trying to make as good time on a lathe built fifteen years ago as they are on a modern lathe especially constructed for this work. They often succeed in making as good time on rough work, but when it comes down to accuracy of their job, then what do they have? You find that they have

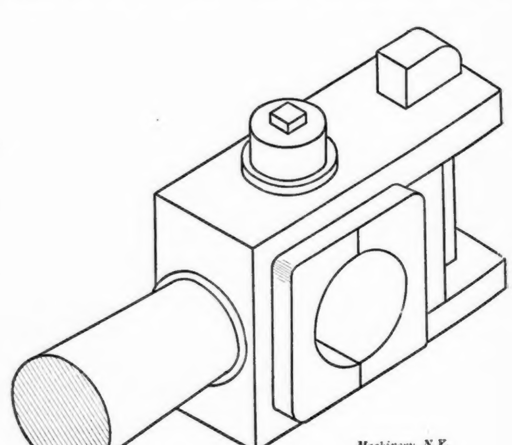


Fig. 4. Connecting-rod End.

sprung the lathe all out of shape; strained the leadscrew, and they have lost motion "to burn" all over the machine. You can not expect to compete in "hogging," with an old lathe as your "hog." This is not only the case with lathes, alone, but with all lines of machinery. The machinery in use to-day must be redesigned to meet the demands of the times.

If you broach this subject to many foremen and ask them how about the wear and tear on the machinery, they simply say that they do the work in so much better time that it makes up for this loss. But it does not, for the simple reason that they are straining every machine in the shop, and the work they do on the machines is not accurate. When it comes to assembling or when work goes to the vise hands, then they put in the time trying to make a job out of some fellow's "bum" work. But you can not do this and save time, so you see in this way you have a poorer lot of work turned out and a shop full of ruined machinery. You go into any shop in this

country that follows such methods and see if their force of vise hands has not increased faster than their force of machine hands, for the simple reason that they need more men to turn out the work in the same time, because the machine work is not properly done.

What is the natural consequences of such lax methods? Why in a short time your machinery does not represent the same standard that it once did, and your trade begins to fall off as a result.

Now to overcome this difficulty you must place a man in your shops at the head of affairs, that is practical, and can improve the methods of doing work, but not at the expense of the machine's accuracy. You want a man that can design special tools, etc., and in many little ways facilitate your progress. However, if you are able, financially, buy the best machinery and then try to keep abreast with the times, by employing skilled labor and employing the cheap labor for helpers. I do not think much of the management of a man that has to employ cheap labor to make a decent showing or profit for the business. I would not employ a foreman that is always trying to grind his men down to the very lowest wages.

The time is now at hand when a man must know a little about his business in a practical and theoretical way. If he does not, a man who does know steps in and takes his place, and he is pushed out in the cold. J. J. JENKINS.

LATHE ATTACHMENT FOR TURNING TROLLEY WHEELS.

Editor MACHINERY:

The service required of trolley wheels, demands that they should be made of as hard a composition as can be machined at a reasonable rate of cost for the work. In the shop where this device for turning trolley wheels is used, this work was formerly done by the following method:

The hub in the casting had a cored hole which was first drilled out, and then reamed to size, the casting being held in a three-jaw chuck, and the work done in an engine lathe. One end of the hub was faced off, and the other end faced by a separate operation. After the hub was finished, the casting was then placed on an arbor, that fitted into the hole in the spindle of the lathe, and was held in position by a nut on the end of the arbor. A pointed lathe tool was then used to rough off the metal in the groove, the tool being made to follow as closely as possible the contour of the groove. After this operation was finished, a tool having the shape of the groove was used for finishing, it being held in the tool-post, the same as an ordinary lathe tool. The width of a trolley wheel is 1⅜ inches, and the depth of the groove ⅜ inch; from these dimensions it will be seen that the last tool had to take a cut that should have had a very substantial machine to do the work. Such was not the case, however, and the whole arrangement was very unsatisfactory. The margin of profit on this work is very small, and it will not pay to put

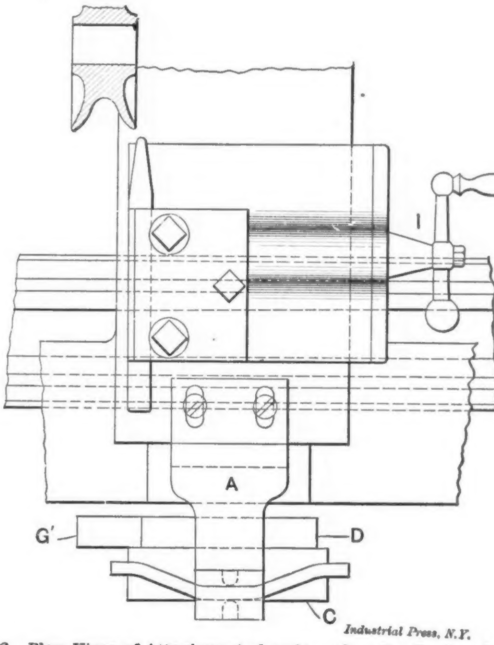


Fig. 2. Plan View of Attachment showing, also, the Tool and Work.

in expensive machinery to do it, so the device described here was designed to do the work.

The work of finishing the hub was transferred to a turret lathe, the casting being held in a two-jaw chuck, the jaws gripping it in the groove. The hole was bored, then reamed, and a tool having two cutters spaced the length of the hub, was then used for facing the hub; one cutter faced the side nearest the chuck and the other cutter the outside face. Thus the hub was finished with one chucking.

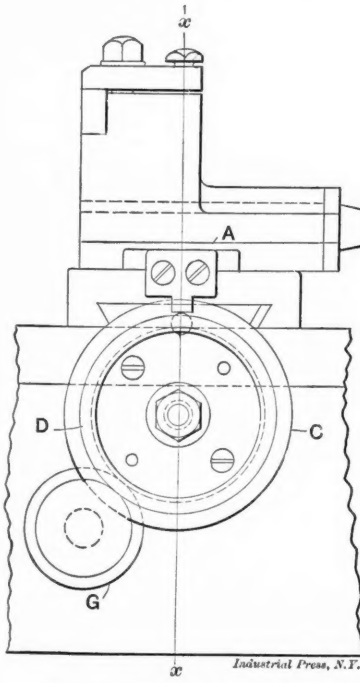


Fig. 1. Front View showing Circular Cam

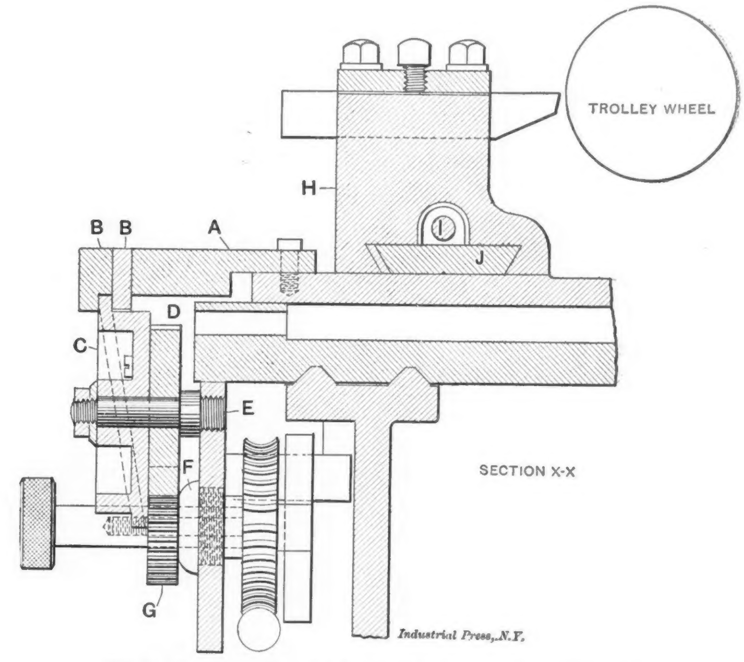


Fig. 3. Cross-section of Lathe Carriage and Cam Attachment.

To turn the grooved part, the engine lathe before mentioned, was arranged to do the work with a round point tool, driven by a cam, so shaped as to give the curve desired. Fig. 1 shows a front view of the device with a portion of the apron of the lathe in sight. Fig. 3 shows a section of the device on the line x x, and also a portion of the lathe and some of the hidden parts of the feed mechanism. Fig. 2 is a top view, showing a portion of a trolley wheel in position and the tool

ready to take the cut. The cam *C* was fastened to a gear, and both revolved on a stud *E*, Fig. 3, which was screwed into the apron of the lathe. The sleeve *F* that supported the hub of the worm gear in the apron, was faced off to allow room for a gear *G*, the pitch diameter of which is shown. This gear was keyed to the hub of the worm gear, and, of course, revolved with it.

The cross-feed screw was removed and an extension, *A*, Figs. 1, 2 and 3, was fastened to the tool carriage in its place. Two hardened steel blocks, *B B*, Fig. 3, having carrying pins, were screwed and doweled to the extension. The pins of these blocks straddle the track of the cam. The cutting tool, of high-speed steel, was supported in a special holder *H*, whose

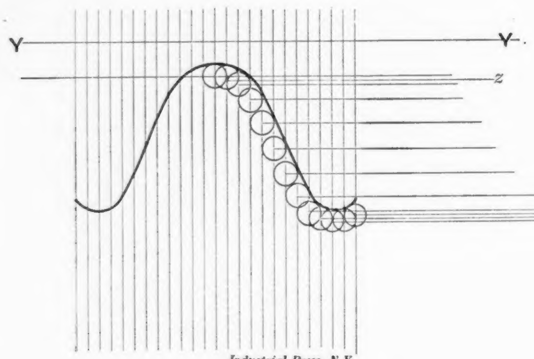


Fig. 4. Layout of Cam.

height was such as to bring the top edge of the tool to a point even with the lathe center. The holder *H* is adjustable laterally by the screw *I*, working in a nut which is fixed to the dovetail block *J*, Fig. 3. Adjustment for depth of cut is obtained by the slotted holes shown in the extension *A*, Fig. 2. This adjustment is but little used, the tools being ground and set to gage.

The construction of the lathe was such as to permit the adoption of this device, it having a feed reversing arrangement in the apron that, at the middle point, threw the gears out of mesh, and allowed the carriage to be run back freely after the cut was made. It was found that one turn of the worm gear gave an inch of movement of the tool carriage and as it was desired to have 1½ inches movement to the carriage to one turn of the cam, the gears were arranged in the ratio of 1 to 1½. The outside diameter of the cam track was made so as to give a circumference of 16 inches. This was done partly for the purpose of laying off the cam readily, and it may be of interest to some of your subscribers to read now this was done to give the curve desired.

This curve was taken from a sample wheel, to which a template was closely fitted and the curve was then plotted as in Fig. 4. Twenty-five vertical lines, giving 24 spaces of 1-16 inch each, were laid off on this curve, the middle line being in the center of the curve. The shape of the tool point was to be a semi-circle of 1-16 inch radius, and in order to obtain the curve the cam should make, circles ⅛ inch diameter were drawn, the centers of which were in the vertical lines, and the sides just touching the curve. From the centers of the circles, horizontal lines were drawn, and a line *Y Y*, representing the back edge of the cam was drawn. The pattern for the cam was spaced on the face of the rim into 24 equal parts, giving a distance of ¾ inch for each space, or a ratio of distance of 12 to 1 of the cam and the curve. The width of the cam track was to be ⅜ of an inch, so beginning at any one of these spaces and at the edge of the pattern, a circle ⅜ inch in diameter was drawn. On both sides of this first circle and on the lines representing the spaces, two other circles of the same diameter were drawn, the distance from the edge of the pattern to the center of the circle being found by measuring the distance from the line *y-y* to the nearest line, *z*, drawn from the center of the circle representing the point of the tool in the diagram. This distance is quite small, and had to be measured carefully; in fact the whole diagram had to be laid out with great care. All the other center distances were found in the same manner as the last, and it only remained after this was done to draw lines from the edge of one circle, to the edge of the next circle, and so on around the pattern to complete the laying out of the track.

The whole device worked better than expected, the only weakness being the carrying pins *B B*, which wear faster than is desirable. The curve generated is so accurate that upon cutting a wheel into two parts the curved surfaces exactly matched. The strain on the lathe is reduced to a minimum and the work is rapidly done.

A simple device for truing the edge of the wheel was afterward added. This mechanism was supported by a bracket, fastened to the lathe head, and consisted of a tool carriage worked by a lever and carrying two tools, the whole device being on the back side of the lathe and out of the way.

J. R. GORDON.

Brooklyn, N. Y.

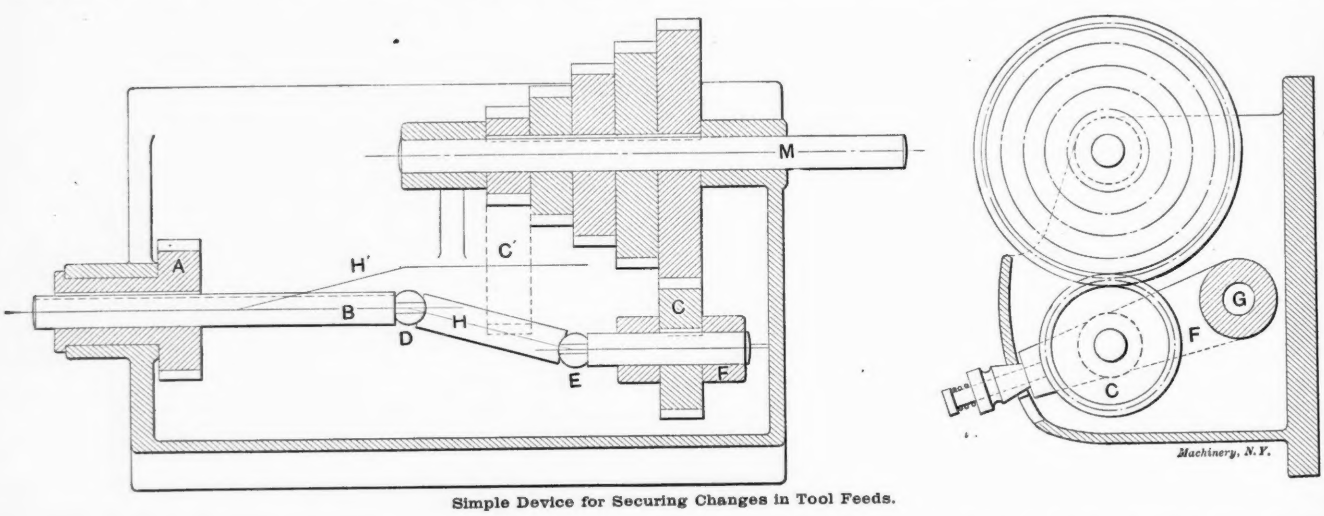
PROPOSED CHANGE GEAR DEVICE.

Editor MACHINERY:

As change gear devices seem to be the fashion about this time I offer the one shown in the cut as being a simple and effective method of getting a variety of positive speeds for tool feeds, screw cutting or machine drives. The drawing is almost self-explanatory. Gear *A* is the driving gear within which slides shaft *B*. Shaft *B* transmits its motion to gear *C* through the shaft containing two universal joints, *D* and *E*. Gear *C* is held in the forked rocker, *F*, sliding on a stationary rod, *G*. The rocker is held in its various positions by a spring catch acting in holes in the casing of the mechanism. Gear *C* may be brought into mesh successively with any one of the nest of gears on shaft *M* and so drives the shaft at corresponding speeds. For heavy service it might be better to have the diagonal shaft *H* made to telescope instead of having shaft *B* slide in the driving gear. *C'* and *H'* represent the position of *C* and *H* when driving the smallest gear on shaft *M*.

E. H. FISH.

Paxton, Mass.



Simple Device for Securing Changes in Tool Feeds.

LABOR-SAVING SCHEME FOR MAKING DRAWINGS.

Editor MACHINERY:

There is always more or less interest taken in a new labor-saving device, and no one is generally able to judge the importance of such improvements better than the designer himself, but seldom does the designer think of improving his own situation by devising a quick method of making drawings.

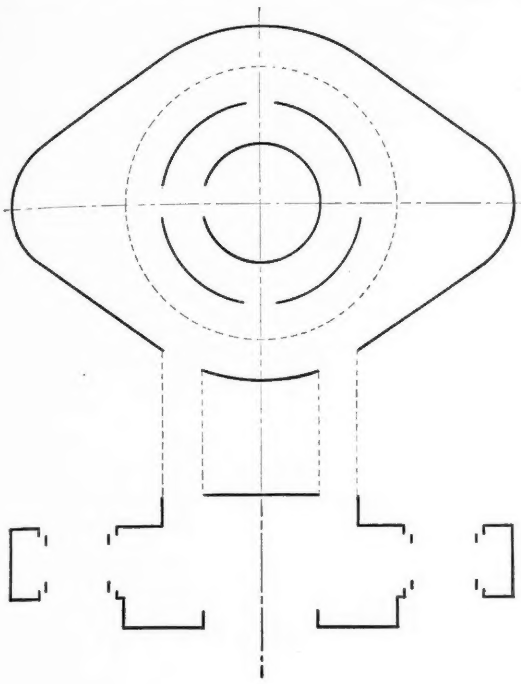


Fig. 1. Drawing Outlined by aid of a Templet.

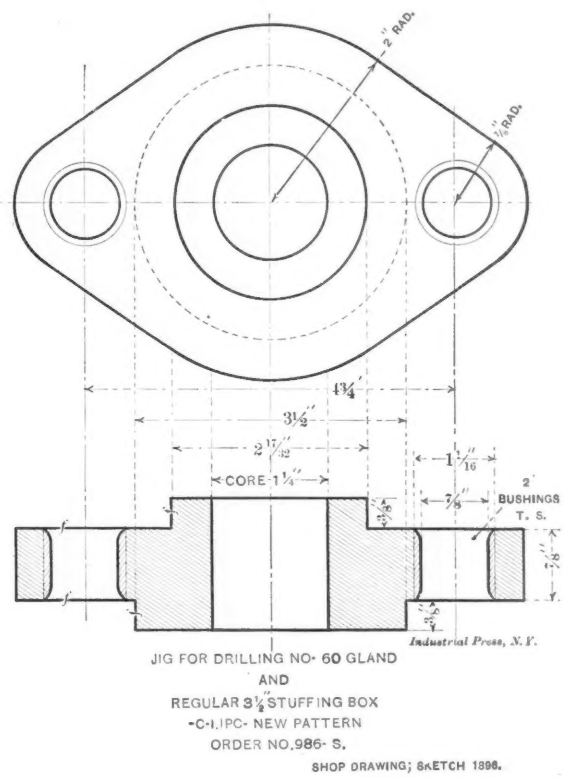


Fig. 2. Completed Drawing of Jig for Drilling Glands and Stuffing Boxes.

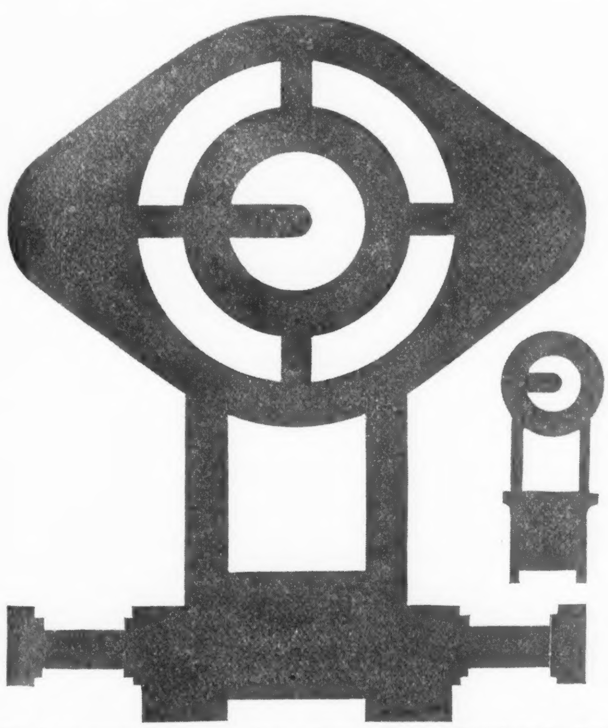


Fig. 3. Templets used for making a large number of Drawings for Jigs.

A short time ago I developed a novel idea for making drawings of jigs for drilling glands and stuffing-boxes. The company I was working for had followed the practice of coring the stud holes in the glands, and after they were machined these glands were used as jigs for drilling the stuffing-box stud holes. The cored holes were not symmetrical, and could not be duplicated, so I was detailed to devise a cheap method of drilling these glands as they were to be cast blank henceforth. This style of gland jig may not be new, but I think the method of making the drawings has not been published.

Fig. 2 shows the style of jig drawing with two counterbores, one for the gland on one side, and on the opposite side a counterbore for the stuffing box. In making this jig drawing I used the templet shown at Fig. 3. This was first drawn on cardboard and cut out as shown so that by tacking on a paper the outline could be made with a pencil as shown at Fig. 1, which is easily filled in to make it look like Fig. 2. The bushings in the jig are for drilling the gland. At the right in

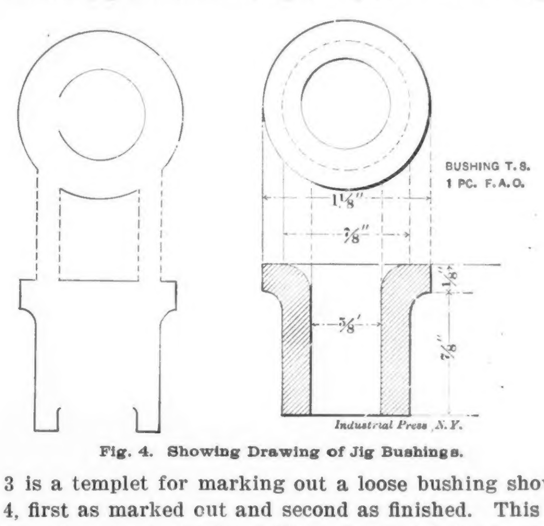


Fig. 4. Showing Drawing of Jig Bushings.

Fig. 3 is a templet for marking out a loose bushing shown in Fig. 4, first as marked out and second as finished. This bushing is used to put in jig for drilling the stud holes in stuffing-box head.

I found that by using carbon paper I could make four drawings at the same time, by placing four sheets of paper under the template with carbon paper in between each sheet. The pressure of the pencil would make an impression strong enough for my purpose. The figures of course I would leave out to be filled in according to the size desired of this style of gland. Some glands were round, some square, with from two

---

C. W. PUTNAM was born in Orange, Mass., June 8, 1862. He served his apprenticeship with the New Home Sewing Machine Co., Orange, Mass., and is now with the Deane Steam Pump Co., Holyoke, Mass., where he is department foreman and designer of jigs and tools. His experience has been mostly in sewing machine manufacture and the building of pumps, both of which he considers as his specialties. Mr. Putnam has contributed a number of articles to the technical press on laying out work.

to four holes to be drilled. There being nearly 500 regular glands of different sizes to make jigs for, this method of making the drawings proved a great success. The drawings were not inked in or made to scale but the figures told the story.

Holyoke, Mass. C. W. PUTNAM.

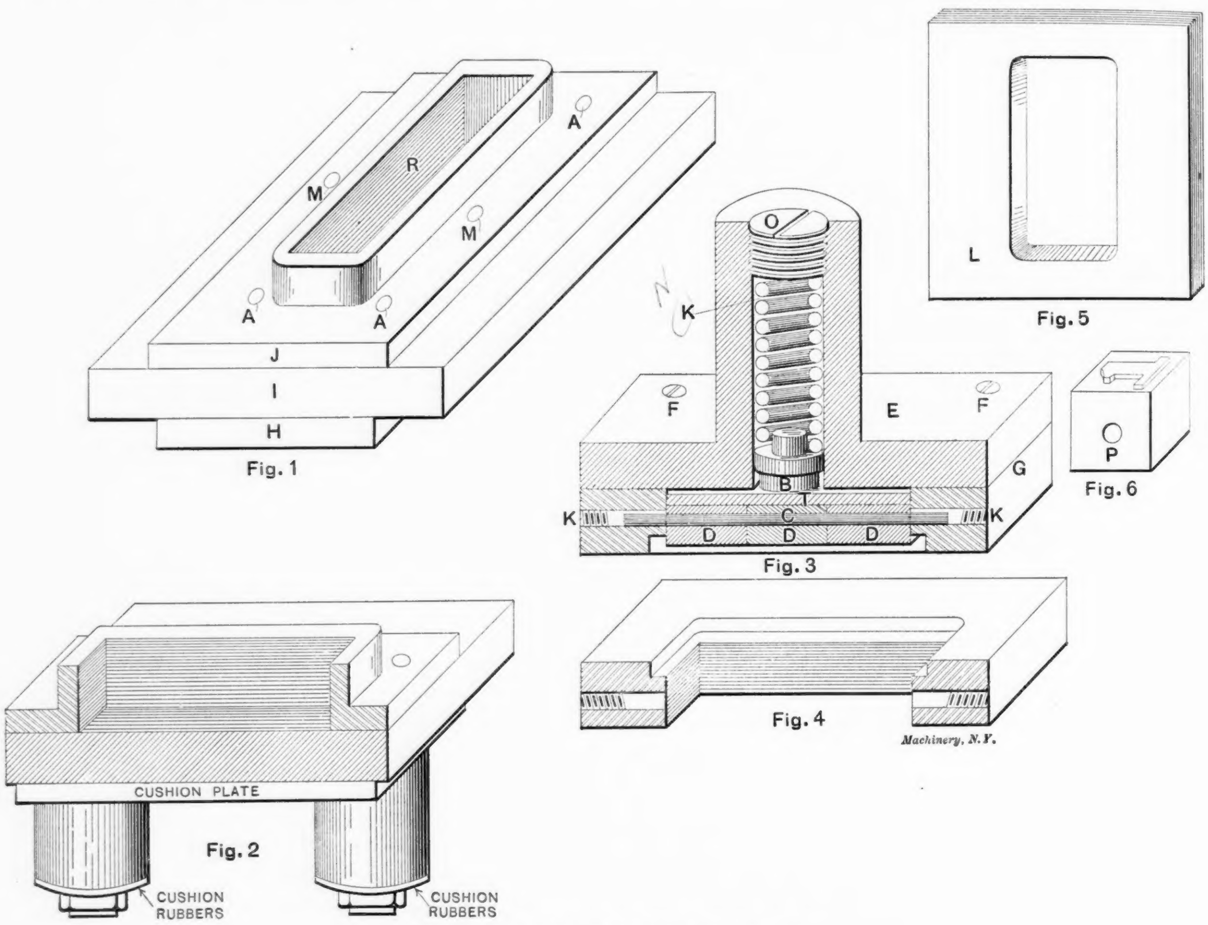
PUNCH AND DIE FOR MAKING NUMBER PLATES.

Editor MACHINERY:

The punch and die shown in Figs. 1 to 6 are for making number plates which are used to number stoves and to designate the different styles of a steel range made in our shop. I think it is quite a novel way of making number plates, and after I have described the die and its workings, I believe the readers of MACHINERY will agree with me, and I hope that it may be of some benefit to others who are engaged in this line of work.

J, Fig. 1, shows the forming die, and the number holder, as I call it, which is of hardened tool steel. The mortise *R* holds the number blocks, shown in Fig. 6, which are interchangeable, and is made to hold three blocks at a time. The number blocks are 11-16 inch × 11-16 inch, and are made of brass; by using two 11-32 inch pieces to make up for the third block, two numbers can be made on the number plate instead of three. The piece *J* is set on the cast-iron piece, *I*, which is made to fit a 4-inch shoe, and held on the block *I* by the 3/8-inch fillister screws, *M*. *A* are cushion pin holes which work on the cushion plate *H*, to keep the metal from buckling while being formed. Fig. 2 shows a sectional view of Fig. 1 with the cushion rubbers in position. Fig. 5 shows the cushion ring, which is mortised out to the shape of the forming die, *J*, and sets on top of the four cushion pins, *A*. The metal is laid on top of the cushion ring, which projects above the top of the die about 1-16 inch, and as the ram descends it forces the cushion plate, *H*, down, and the tension of the cushion rubbers keeps the metal from buckling.

Fig. 3 shows a sectional view of the female part of the die. The upper half of the die *E* is made of cast-iron and a 3/4 inch hole is drilled through the shank for the spring *N*. Fig. 4 shows a sectional view of the lower half of the die, *G*, Fig. 3; it is made to conform to the shape of the forming die, *J*, Fig. 1, and is made twice the thickness of the metal larger. Fig. 3 shows the female number blocks, *D*, in position. These are held in place by the rod, *C*, the blocks having a hole 5-16 inch diameter drilled through them, as shown in Fig. 6, at *P*. The two screws, *K*, are to keep the rod *C* from coming out. These blocks act as a kicker, which accounts for the hole being drilled 5-16 inch in diameter, as the large size allows the blocks to work free and bottom on the upper half *E* or shank holder. The piece *T* is a loose piece laid on top of the blocks, *D*, so as to get even pressure on all of the blocks. The piece *B* rests on top of the piece *T*. As the width of the



Views of Punch and Die for Stove Number Plates.

Fig. 8. Plate after being Trimmed.

Fig. 7. Number Plate as it leaves the Press.

blocks is only 11-16 inch, I had to use this means of making an effective ejector, as the spring hole being ¾ inch in diameter it would not allow the spring to come in contact with the piece *T*. The lower half of the die *G* is fastened to the upper part by means of the four fillister screws, *F*. *O* is a tension plug and keeps the spring from coming out.

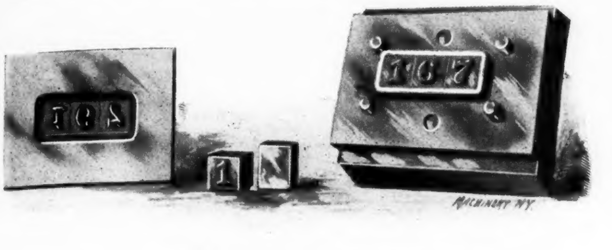


Fig. 9. From a Photograph of the Punch and Die.

One advantage of this die lies in having the numbers interchangeable; it only requires a few blocks, whereas if each number was all made in one, it would require a great many number blocks. Constructed this way it makes a very neat tool and produces just as good a work.

Lorain, Ohio. W. VAN ORMAN.

ADJUSTABLE HOLLOW MILL.

Editor MACHINERY:

I send below description of an adjustable hollow mill that can be used where the collar clamping device of the ordinary form is in the way. It was developed in our shops two years ago, and is the joint production of my foreman and myself.

Referring to Fig. 1, *A* is a machine steel shank fitted to the drill press or other machine in which it is to be used. It is threaded at *a* and the lower end is turned down so as to form

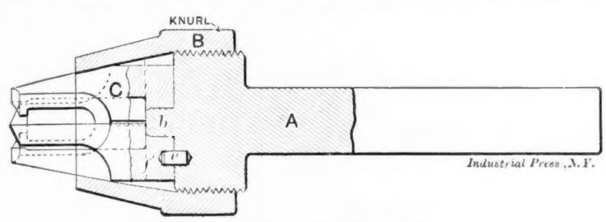


Fig. 1. Section of Hollow Mill.

the stud *b*. *B* is a collar or sleeve similar to those used on adjustable chucks for holding small drills. It is also of machine steel, is threaded to fit the shank *A*, and below the threaded portion is bored taper. *C* is the hollow mill of the ordinary split collar type, except that at the upper end it is bored to fit the stud *b* and a portion of the outside is turned taper to fit the collar or sleeve *B*. In the lower end of the shank *A* is inserted a driving pin *e*, which enters a hole *f* in the upper end of the mill *C*.

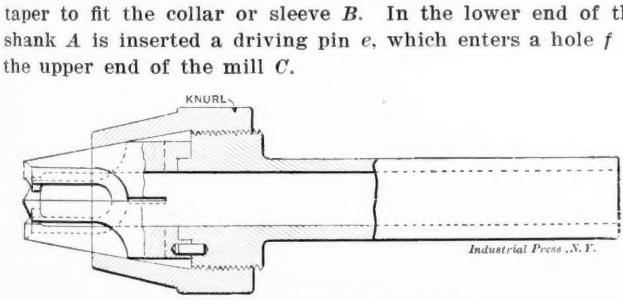


Fig 2. Hollow Mill for Long Work.

The above described tool can only be used for short work, but the modified form shown in Fig. 2 will take work of any length.

Our mills are made a trifle larger than the desired size and squeezed down by the taper collar *B*. This affords a delicate adjustment for size and at the same time keeps the teeth of the mill concentric with the shank. V. H. MARCELLUS.

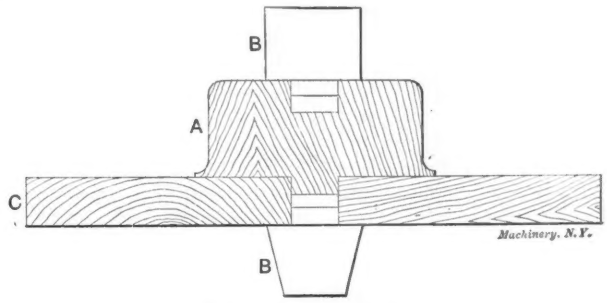
Belvidere, Ill.

PATTERNS FOR CHUCK PLATES.

Editor MACHINERY:

For a number of years we fitted up chuck plates in the same way that most other lathe builders did. That is, we hunted through all the patterns we had or our neighbors had at the foundry. After spending just about time enough to make a good pattern we tacked a couple of thicknesses of leather belt around the rim of one and used a hub that was a mile too big, but had about the right size core print, and trusted to luck to remember to turn the hub down a little. The principal variation from this method was when we found a hub about the right size but with a 2-inch print where we wanted a 1½-inch core set. The molder usually got it near enough the middle so that we could use it except when we were in a great hurry.

We finally rebelled and got out a set of patterns that worked well enough so that the other lathe builders were perfectly willing to borrow them. We turned up a set of hubs as at *A* in the cut, making the diameter of the hub about 1¾ times



Pattern for Chuck Plate.

the diameter of the nose of the spindle it was intended for. These hubs had a dowel made on one side 1 inch in diameter, as shown, and on the other side a corresponding hole. Sets of core prints were also made of sizes to correspond to the standard foundry stock cores and of a size to allow about ⅛ inch on a side to bore out before threading. These core prints were all made with 1-inch dowels, as shown, and were stamped plainly with their actual size and the size lathe for which they were intended. The hubs also were stamped with the lathe sizes. The plates *C* were made to suit the diameters of plate called for by the makers, whose chucks we were mostly using, and were stamped with their finishing sizes, that is, the size they were intended to finish to. The thickness of the plates varies from one-eighth of the diameter for small plates to one-twelfth for plates a foot or more in diameter.

A full set of hubs and core prints was made at once and a few of the most used sizes of plates. After that if a new size was called for it was a matter of only a very short time to get out a new plate. E. H. FISH.

Paxton, Mass.

ACCURATE JIG MAKING.

Editor MACHINERY:

Kindly allow me space for a few words regarding accurate jig making. I was somewhat surprised to note in the current issue of MACHINERY that Mr. J. R. Gordon prefers a drill press to either the milling machine or button method for accurately spacing holes. Undoubtedly brother Gordon failed to state how he overcame the following unquestionable chances of errors, and I will point out where the drill press is not allowable for jig making in watch or fine instrument factories. When writing the article on jig making in the July issue, I had in mind the method of spacing as advocated by Mr. Gordon; in fact, I described that same method applicable to the lathe in the January, 1904, issue of MACHINERY, but it is accurate only when holes are *bored*. Let us see how many chances for error are presented when employing the drill press plan of spacing. First, the bracket or arm, that is fastened to drill press and which holds the bushings used to guide the drills must be made perfectly accurate; that is, the hole in said bracket must align absolutely with center of drill spindle. Secondly, the bushings to guide drills must be made so that the hole is perfectly concentric with the outside. Third, the hole in bushing must fit perfectly the drill used. Fourth, the outside of bushing must fit perfectly the hole in bracket, to insure the hole in bushing remaining absolutely central with spindle when using bushings with different sized holes. Fifth, the spindle of drill press must be at right angles with table of press in every direction, a condition that is rarely met with in a drill press.

Mr. Gordon spots the holes using spacers made of drill rod. The bracket is removed and the holes drilled clear through the jig plate. But what assurance has he that the drill continued through the plate perfectly straight? None whatever; hence, chance for error No. 6. When drilling work fastened to face plate of lathe we always bore the hole to "true" same. Now, why will a sensitive drill press, that is more sensitive to "spring" than anything else, produce a hole that requires no boring? Seventh chance for an error is when the holes are opened up with a half-round center reamer having but one cutting point. Cast iron is full of grit and it requires but a small particle of grit to cause the center reamer to change its location. Eighth, and greatest chance is that of opening the holes with a larger drill. If one lip of drill is the least bit longer than the other it is therefore doing more work and tends to crowd the drill over to opposite side. Error No. 9 is when the hole is sized with a reamer. I repeat my statement made in August issue of MACHINERY, that when absolute accuracy is required, the hole must be bored. Error No. 10 is the personal one, caused by uneven tension on measuring instrument when making the drill rod spacers. True, the error in all cases may be very slight, but if there are, say, 20 holes in the jig, the multiplication of errors will amount to considerable. It is very doubtful if a jig, made in above stated manner, could be duplicated. When using the buttons for spacing as I described in the July issue there is but one chance of an error and that is the personal one caused by uneven tension on measuring instrument, due to the fact that the buttons are indicated and holes bored. Mr. Gordon meets this same personal error when making his spacers. I agree fully with Mr. Gordon as regards the condition of milling machines in most factories. But I stated very clearly that the milling machine method was applicable only to those being fitted with corrected screws and dials. Any manufacturer that holds accuracy in the tool room as the prime factor, and also expends $125 for three milling machine screws is very careful that a "cut meter" is not employed on that miller and reserves same for "Accurate Jig Making."

Gt. Barrington, Mass. FRANK E. SHAILOR.

SETTING FOR TURNING TAPERS.

Editor MACHINERY:

The following method for tapers may be of interest to some of the readers of MACHINERY; they have been of use to me many times:

When turning a rod to a certain given taper, or to fit a taper hole, if the taper is given, for instance, ⅝ inch taper per foot, and the piece is an odd length, say, 31 inches, instead of figuring the distance necessary for 31 inches of length I simply set the tool at a point 2 feet from the live center and adjust the cutting edge to a distance ⅝ inch from the work. This I usually do by taking a piece of ⅝-inch steel and set the tool so that it will pass between it and the work. I then set the tail center over so that the work will touch the tool. This gives the desired taper very easily, even if the rod is three or four feet in length.

If the hole to be fitted is, for instance, 5-32 inch taper to 3¼ inches in length, take, say, $8 \times 3\frac{1}{4}$ inches $= 26$ inches and $8 \times 5\text{-}32 = 1\frac{1}{4}$ inches. The distance necessary to throw the tailstock would be one-half of 1¼ or ⅝ inch measured from the end of the setting tool at a point 26 inches from the live center.

To bore a hole to a given taper with a compound rest I usually set a piece of shaft, rod or mandrel by this method and then adjusted the compound rest to the arbor with a tool set at the same height as the center for a guide. It is much easier than to cut and try, or to set to certain degrees by use of a bevel. I have worked in many small shops where the taper attachment was an unknown quantity and there the method just described is most valuable. J. T.

* * *

The air-lubricated journal, described by Mr. A. W. Cole in our issue of May, 1904, was designed and built by Prof. Albert Kingsbury and was used by him in his experiments on the theory of lubrication.

THE APPRENTICESHIP QUESTION.

The trade schools, night schools and the engineering shops do what they attempt to do all right, but do not fill the shop requirements. Boys become students in the trade schools because in many cases that is the best they can do. Learning to fit pieces of wood together in different shapes or in all shapes will not train a boy to be a carpenter and joiner, or patternmaker; chipping and filing, turning and planing, milling and drilling, and scraping will not make a machinist nor learning to make drawings of buildings make an architect.

Neither is it possible to make an architect in the way I believe it possible to make a machinist, patternmaker, molder, plumber, etc. They do not pretend to make architects in the trade schools any more than I would pretend to make mechanical engineers in the school of trades. They do come very near making brick masons at the Jewish school at New York by the trade school methods. That is to say that brick walls are built as they would be in a building by the students and then torn down to be built up in some other way by other students. Plumbing is taught similarly, that is, pipe can be screwed together and unscrewed to be used over, and lead pipe can be soldered and unsoldered, and for those two trades it is unquestionably a fairly good way.

But that way will not do very well for a foundry and not at all for patternmaking or machine work. In patternmaking the thing done must be good enough to use or it is practically a total loss and in a machine it is the same in the main. The different parts done in most of the college shops are simple exercises, pieces chipped and filed in some instructive form to drill the hand in special skill, and the work when done thrown into the scrap heap. Other exercises are in the use of the various machines, attention being directed to how the work is done, rather than to the ultimate use of the piece. Just whether this is the best method for the mechanical engineer it is not my purpose to discuss, but that such a method would not make draftsmen, patternmakers, molders and machinists, I am quite sure.

To make good foundrymen the boy must work where castings are made to be used and where the cost of the product is an important part considered, and this is the weak part of the college foundry. In the school pattern shop the cost of the work is much less likely to be considered than in the foundry or machine shop, as it is in all shops where the three are carried along together in the same establishment. In the new order of things where patternmakers are carrying on business and competing with each other the question of cost is brought down immensely by competition, and in many cases this is carried to such an extreme as to result in poor work, and one of the hardest things to teach patternmakers is to consider the ultimate use of the pattern. The poor patternmaker cannot make a pattern that needs to be good, good enough, and it is hard to get a patternmaker who is used to making good patterns to turn out a pattern from which only one or two castings are to be made, crude enough. In a patternmaking school this could easily be made a part of the training.

If one is to learn to be a machinist he must work where machines are made, and, too, where many kinds are made. To get this varied experience, it takes the apprentice and young mechanic many years of time, and generally going from place to place. Whereas in a school this varied experience could not only be obtained at one place but in much less time.

In the ordinary shop, in fact in all shops, except in those cases such as Brown & Sharpe's, where a special instructor is employed, the apprentice has to acquire the trade by absorption, as it is no one's business to instruct him. He gains his knowledge by what he can see, and the bad habits, negligent and indifferent ways and methods are as easily absorbed as the good ones, and the progress at best is slow.

Where the whole business of the boy would be to learn and the primary business of the foreman to teach, and to teach the best known ways, a year or two's time would be added to the useful life of the man and the money value of this year or two's time saved would far more than pay the young man to

Paper read by Prof. John E. Sweet before the Syracuse Metal Trades Association, July 22, 1904.

work for nothing for three years than to be paid apprenticeship wages in the ordinary shop, though the primary trouble is, he cannot find the places to learn the trade even in the present indifferent way.

In reply to the prevalent notion that a boy cannot learn a trade in school, let us see if we can tell why the following plan would not work. Take a well-organized shop with all the tools and machines necessary to do various kinds of foundry, pattern and machine work, with drafting room, offices, etc., and I would add a school room, not particularly different otherwise from a regular shop except there shall be no dividends or taxes to pay. The running expenses for the first year would be insurance, coal, water, oil and engineer for power, material and general supplies, a small office force, foreman and instructors or journeymen, a sweeper and watchman and a very little in the way of helper, as that would be as in an ordinary shop, only much more largely so, done by the freshmen. Now the first year it would be too much to expect the enterprise to be self-sustaining, but the second year a change for the better could not help but show itself. Such of the boys as had not fallen out would have a year's experience and some of them would in certain ways be, by their superior opportunities, pretty good journeymen, and replace some of the hired journeymen of the year before. Some would have shown their ability for draftsmen, some office men, some foundrymen, some patternmakers and others machinists and likely some more drop out.

The third year still more of the employed help could be dispensed with, better and more difficult work intrusted to the students, those showing the ability set to doing the drawing and so learn the relation between the drawings, patterns and finished work. Some set at tool-making and those few that show the ability, inclination and have the means, started in the necessary preparatory work to enable them to enter the College of Mechanical Engineering. In this respect the school would become the sorting ground for the university.

The fourth year men would be enabled to fill nearly every place in the institution. The history of our times show that of those who learn the machinist's trade many make machinists, some make stationary engineers, some draftsmen, some clerks, some business men and some mechanical engineers, and this combination is exactly the combination that it takes with the patternmakers and founders to run a successful shop, and that is exactly what the successful school for apprentices has got to be.

The question naturally arises what is to be made to sell that will sell for enough to pay running expenses? At first such things as require the least expense for material and furnish the most work, as the work in the main will cost nothing, no matter how much of it is put upon a piece, if the piece will sell. Later better and better work could be done and as the final test will be the character of the men turned out, the best men can only be made by doing the best work. If better work is turned out than anywhere else, then the ordinary shops cannot complain that the school shop interferes with trades union labor.

As I have indicated a school room, that implies some school work that could be imparted in two hours a day, and of just the kind that would be of the greatest use to the mechanic or necessary to enter a technical school. Certain things such as writing, spelling, arithmetic and the civilities of life should be insisted upon, and beyond that such as the ability of the student seemed to justify.

When the school turns out men that there is a demand for, the reputation of the school would soon be such that the boys would covet the chance to be given admission and many parents willing to pay tuition fees, the same as at college. But after all would it pay dividends, taxes and insurance? No. Does it pay young men to go to college? Well, some it does and some it does not. Does it pay to go to school? Sometimes it does and sometimes it does not. Does it pay to learn a trade? Generally, and it is one of the best ways to keep men out of State's prison and the poorhouse.

But how is the fanciful school I have been describing to be brought about? It isn't in my time, but I hope in some of yours. Such changes before they materialize have to be harped upon by some man for about twenty years, then if he gets some one to help pick the harp strings with him the idea will grow, and in this case slowly, because it not only requires a change in sentiment, but money.

I can see no hope until the happy coincidence comes about by there being a good machine shop in the receivers' hands and the time when the glory of giving money to colleges, libraries and hospitals has grown stale, and the millionaire buys the shop, donates and endows it for the purpose.

What interest is all this to this association? First, to keep the supply of good workmen up to the demand, and second, to bring up a set of better educated men and further to fortify manufacturers against labor troubles.

It may be easily imagined that I am laying unnecessary stress upon the importance of the machine shop to our lives, but if we stop to consider one prominent fact it will be seen that we must have the machine shop or go back to primitive methods, as the machine shop is growing of more and more importance.

Everything is being done more and more by machinery and that means more and more shops to build them in. The technical schools are training engineers and men to lead, but it takes from ten to a hundred men to execute the work of an engineer, and nothing is being done, or certainly less and less is being done, to train them. Unless not only one but hundreds of such schools as I have described are provided, foreign workmen will find work in this country and promote idleness in our own young men.

If the old apprenticeship system is revived it can only be done by change in sentiment as to the relative value of an academic education and a trade. Whether it is of more value, and whether it is more likely to lead to happiness for one to know what has been done in the world or for one to know how to do something himself, will be the question. When a parent comes to the conclusion that he wants his son to learn a trade and is willing to pay the price, manufacturers will be willing to accept the money and give the boy a chance, or there will be money enough drifting the right way to establish the schools.

* * *

Compressed air is widely used on railways for cleaning the cushions, carpets, draperies, etc., of passenger cars, and it has been found far superior to the beater, broom and duster method. But it has one serious fault in common with the ordinary implements of cleaning in that it scatters the dust through the air, which, as soon as the disturbance has ceased, settles again upon the furnishings. For this reason the vacuum system of cleaning seems likely to supplant compressed air for railway car cleaning, and because of its great efficiency it is also likely to be largely employed for the annual or semiannual "housecleaning" in hotels, private houses, etc. With the vacuum system everything is cleaned *in situ*, there being no need of taking down curtains or pulling up carpets. The dust is sucked out of them, even that which has penetrated carpets and lies on the floor beneath. The vacuum system, of course, requires a vacuum pump, or, in other words, an air-compressor in which the suction is the "business end" instead of the discharge pipe. For house-to-house work a portable plant is necessary, and the business has already reached the point of development in this country where the portable plants are being introduced. One recently built in New York consists of an inclosed electric automobile truck, in which is a three-cylinder gasoline engine connected to a small dynamo. This dynamo charges the storage batteries, from which current is drawn for running the truck and for operating the vacuum pump. This latter is in the back of the car and is driven by a small motor connected by a Renold chain drive. The pump is a vertical two-cylinder machine, having a capacity of about 400 cubic feet of free air per minute.

* * *

Three thousand employees will be required to operate the trains of the New York subway when it is opened next month, and most of them will require special instruction to qualify for the work. The arrangements for giving this instruction are so complete, that it is expected all the trains will be running on schedule time within an hour-and-a-half from the time the subway is opened to the public.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

We have received the following inquiries from our subscribers, which we are glad to submit to our readers as subjects upon which some among them may be able to supply information that will be of general interest:

1. W. C. J.—Will you kindly tell me how axes and hatchets are made, especially as to the way in which they are finished and tempered?

2. C. K.—Will you kindly inform me of the best prescription for thinning lard oil after it gets thick from using?

3. H. J. N.—Can you give me any information regarding the use of aluminum for gas or gasoline engine castings? Can it be used for cylinders, and, if so, of what composition should the alloy be? Also, can an aluminum mixture be used for the bedplate? The engine in question is for a gasoline launch to develop from 10 to 15 horse power.

4. B. and R.—Is there any means for protecting highly polished steel surfaces from rusting after soldering? We have tried several so-called anti-acid soldering solutions, but none of them prevented the subsequent rusting of the polished surfaces coming in contact with them.

5. "Connecticut" asks: Will you give me some idea in regard to making a straightener for brass wire 1-16 inch diameter? The wire has considerable spring in it. I have tried an eight-wheel straightening machine, but it does not accomplish the work desired. I do not want to mark the wire.

6. Inquirer: Can you give me information upon designing an 8, 10 or 12-tooth cast-iron sprocket wheel, for No. 32 malleable chain? I would like to have dimensions for the addendum, dedendum, thickness of tooth, clearance, etc.

Answers to Question 33.

The two following replies to the inquiry of C. W. B. for a solution or solder for soldering brass and steel together without rusting, have been received:

1.—Non-corrosive soldering fluid.—Grain alcohol, 3 pints; glycerine, ½ pound; chloride of zinc, ¼ pound. Glycerine to be well shaken or mixed with the alcohol before introducing chloride of zinc. After introducing the zinc to the alcohol-glycerine compound, mix thoroughly by shaking until the chloride is dissolved. Any combination of quantity may be used if the proportion is maintained.

2.—A saturated solution of chemically pure zinc chloride in best grain alcohol will give good results. It is equally good for copper.

About Sepia and Blue-print Paper.

We have two inquiries regarding sepia and blue-print papers. The first correspondent incloses a sample of sepia paper and asks, "Will you kindly advise me, if possible, as to what composes the solution used in making sepia printing paper? Also, whether there is any solution that can be used for making corrections on such paper?"

This inquiry was referred to our contributor, Mr. W. H. Sargent, chief draftsman of the Fairbanks Scale Works, St. Johnsbury, Vt., who replies as follows:

I regret that I cannot give you the formula for preparing "sepia paper" or "maduro paper" as it is sometimes called. It appears to me to be similar to "Kallitype" paper, described in the *Camera* for May, 1903 (The Camera Pub. Co., 114-120 So. 7th St., Philadelphia), also described in *The Photo Minature* No. 47, Tennant & Ward, 287 Fourth Ave., N. Y. City. So much depends upon the selection of the paper and the preparation of the chemicals that the work of an amateur is likely to be unsatisfactory.

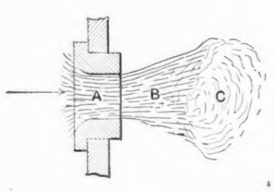
The sepia paper may be written upon with "Farmers' Solution," which consists of a few grains of red prussiate of potash (potass. ferryicyanide) with an equal amount of hyposulphite of soda. Pulverize the crystals and dissolve in an ounce of water. The proportions are not very exact—the stronger the solution the quicker it acts. The potash is very poisonous.

The second inquiry relates to making prints from, or reproducing blue-prints. As we have seen work of this character at the works of the New Britain Machine Co., New Britain, Conn., we submitted the inquiry to them and have the reply, which follows. These two inquiries and information given may, we trust, lead to information from other sources upon these subjects, which are of considerable interest to draftsmen.

With regard to reproducing blue-prints, we would state that we get out a considerable number of bulletin blue-prints consisting of part drawings and part type-written work. The foundation for these is a reversed blue-print made from a Vandyke process paper negative. This Vandyke process, as you undoubtedly know, is exploited by Eugene Dietzgen & Co., New York and Chicago. It was invented by a draftsman of ours, Mr. Schmelz, and gives a deep Vandyke brown background with white lines, and, of course, in reprinting from them with ferro prussiate paper, one gets blue lines with white background. A bulletin mailed you was made from a glass negative made by a wet process plate, by photographing a combined sheet of drawing and type-written work—the latter made with black record ribbon.

7. A. J. J. and others—We cannot understand the use of the expanding nozzle in the De Laval steam turbine. It would seem quite useless to generate steam of high pressure and then expand it idly before delivering it to the wheel. Why not use a straight nozzle and simply limit the boiler pressure in the first instance? 2. Why is it that steam when flowing through a straight nozzle superheats, while when flowing through a diverging nozzle, as that of the De Laval turbine, it condenses?

A.—It is necessary to expand the steam in order to get the full amount of work out of the steam that it is capable of performing. There is a large amount of stored heat energy in steam which can be converted into useful mechanical work even when the steam has been cut off entirely from the boiler; and it is this energy which is made use of by expanding the steam. In the case of a steam engine, steam is cut off in the early part of the stroke, but it continues to push the piston forward with a gradually lessening force, in virtue of its own intrinsic energy, which causes it to expand. In the case of a direct-acting pump, steam is admitted during the whole of the stroke. Practically considered, there is no expansion at all, with the result that this is one of the most wasteful forms of motors. In order to take full advantage of this expansive force in a steam nozzle the walls of the nozzle must diverge, as can be explained by reference to Figs. 1 and 2. It has been proven by many experiments that when a converging or straight nozzle is employed, like in Fig. 1, steam will expand in the nozzle to about 6-10 of the boiler pressure, under ordinary circumstances. This is true whether the boiler pressure is high or low. The result is that when the steam leaves the nozzle it at once drops the other 4-10 in pressure, and the jet of steam at once expands to a larger diameter, and its energy is dissipated in producing eddy currents, and in friction, instead of giving the steam velocity.



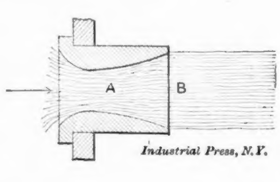


Fig. 1. Fig. 2.

In Fig. 1 the pressure at *A* would be about 6-10 of the higher pressure, and at *B* is shown how the jet bulges out and how its energy is lost to a certain extent. Steam flowing through such a nozzle acquires a velocity of from 1,400 to 1,500 feet per second, this velocity being nearly constant for all pressures within certain limits. If, however, we attach a diverging mouthpiece to the nozzle, as in Fig. 2, having the area increase from *A* to *B* just sufficient to confine the steam so that it will be compelled to expand in the direction in which it is flowing, instead of radially, the energy will all be directed to giving velocity in the direction of flow, and the steam will issue in parallel lines at a much higher rate of velocity, which rate will increase with an increase in pressure in the boiler.

The reason the nozzle must diverge in order to produce this result is because steam at a low pressure has a greater volume

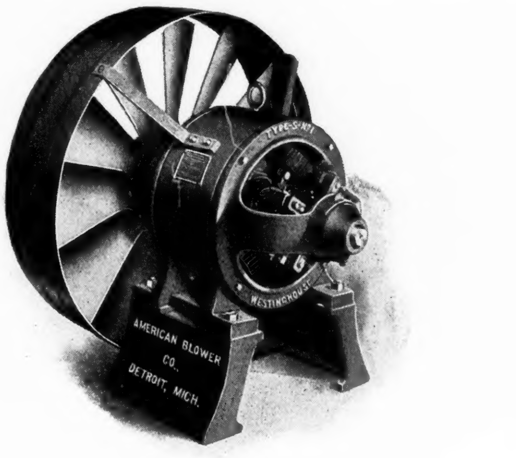
than steam at a high pressure; and consequently increasing room must be given it if the pressure is to drop within the confines of the nozzle. The flare of the nozzle is modified somewhat, however, by the fact that the velocity of the steam is rapidly increasing and consequently the steam gets out of the way faster toward the discharge end of the nozzle and the area at that point can be proportionately smaller than if this were not the case. Theoretically, the ratio of the areas at *A* and *B*, Fig. 2, should be directly as the specific volume of the steam at these two points (remembering that the volume at *A* must be for steam at 6-10 of the higher pressure) and inversely as the velocity of the steam at these points.

2. The answer to your second question must be evident from an examination of Figs. 1 and 2. In Fig. 1 the energy of the steam is dissipated in friction, and eddy currents, which produce heat and superheat the steam. With a diverging nozzle, however, the steam flows smoothly from the higher to the lower pressure, and all of its stored energy is converted into kinetic energy (the energy of motion). The high velocity of the steam in this case is the direct result of the expenditure of the stored energy in the steam, and inasmuch as this energy has been given up the steam has lost part of its heat and consequently has condensed.

* * *

VENTILATING BLOWER WITH MOTOR.

The American Blower Co., Detroit, Mich., have worked out a new design for direct-connected disk fans, as shown in the accompanying illustration. The fan is a modification of the "A B C" fan of this company's make, which has been on the market for a long while and is in general use. The custom has previously been to attach the motor to the arms of the fan, but the excessive weight of the overhung motor has



sometimes been an objection. In the present combination the motor is placed on a substantial base, and the fan is supported by the motor frame by means of radial arms, as shown. The fan, which can readily be made very light in weight, is thus the overhung part of the apparatus. There are no bearings except those of the motor. The complete apparatus is compact and well adapted for ventilating purposes. The fan is equipped with Westinghouse motor.

* * *

IMPROVED DRAFT GAGE.

The importance of being able to tell the chimney draft at a glance is fully recognized, and the necessity of knowing the pressures maintained, where quantities of air are moved is becoming more apparent to ventilating engineers. In testing gas engines for their thermal efficiency, the pressure of the gas as well as the barometer readings must be accurately recorded if correct results are desired.

For such purposes an ordinary U-shaped glass tube has been used and the difference of the level of the liquid in the two legs taken as the pressure. Aside from the fact that one can seldom read closer than ¼ of an inch on account of the menisci varying with the direction of movement of the liquid and that one must take two readings and add or subtract to get the correct result and that the tube is fragile and often gets broken, the device gives good results.

In order to read closer than ¼ of an inch, a glass tube has been used in an inclined position, giving a 10-inch travel for 1-inch rise. This makes the readings finer but limits the range for practical purposes as a tube showing a difference of pressure of 6 inches would be five feet long.

To meet the requirements for a strong, direct-reading manometer that would give close results and could be used either as a portable instrument or could be attached to the gage board, an interesting draft gage has been brought out by Mr. C. E. Sargent, mechanical engineer, Chicago, and is for sale by Schaeffer & Budenberg, New York and Chicago.

It consists of a nickel-brass cylinder, closed at both ends, encircled with a spiral groove in which is wound a transparent flexible celluloid tube, the bottom end of which is cemented in and communicates with the interior of the brass chamber.

An extension of its lower head passes through the bracket, which supports the gage, yet allows it to be revolved at will, around its vertical axis. A small hose cock, to which a rubber tube can be attached, admits pressure through the top head of cylinder. Distilled water, usually colored, is put in the cylinder through this cock until the zero mark is reached on the scale.

Pressure will cause the level of the liquid to ascend in the tube and for every inch of vertical rise, it will travel around the cylinder, a distance of about 9 inches, which is divided into 100 equal parts. The angle of the tube is such that the plane of the minisci is radial, making close reading possible. The cylinder can be rotated so that the level of the liquid comes on the front side.

Rarefaction causes the liquid to descend, and by adjusting the cock, any degree of steadiness of the level in the tube may be obtained. The upper end of the tube is closed with a screwed brass plug and the inlet cock is shut when the gage is carried about, maintaining the liquid in place without danger of spilling.

As the tube is tough and elastic, it is not liable to be broken. The whole device is 3 inches diameter by about 12 inches long, and weighs about 3 pounds.

* * *

A large industrial plant for the manufacture of "fiberloid" has recently been put up at Indian Orchard, Mass., consisting of 20 brick buildings. Fiberloid is practically the same as celluloid, but it is made from a different base, by a somewhat different process. The base of celluloid is tissue paper, while fiberloid is made from fine cotton yarn or rovings. Collars, cuffs, combs, brushes and mirror backs are some of the products manufactured at this plant; also large sheets of fiberloid of various colors, from which are made various articles such as imitation tortoise shell combs. These goods were formerly manufactured by the dry process in which there was some danger from explosion, but in the new wet process they are said to be entirely safe. The plant is built in the latest design and most approved methods of modern mill construction, and covers a large area of ground. All the buildings are heated and ventilated by the Sturtevant fan system and not only is this system applied for heating and ventilating but also for special drying, cooling and exhausting arrangements. In the sheeter dry house there is a special Sturtevant drying apparatus for drying the sheets of fiberloid; in the sheeter room is a special cooling apparatus for maintaining an even cool temperature necessary in the process of manufacture, and a special ventilating equipment is installed in the rolling mill to keep the atmosphere pure and healthy. The equipment of this extensive plant illustrates some of the various uses to which the fan is now applied.

* * *

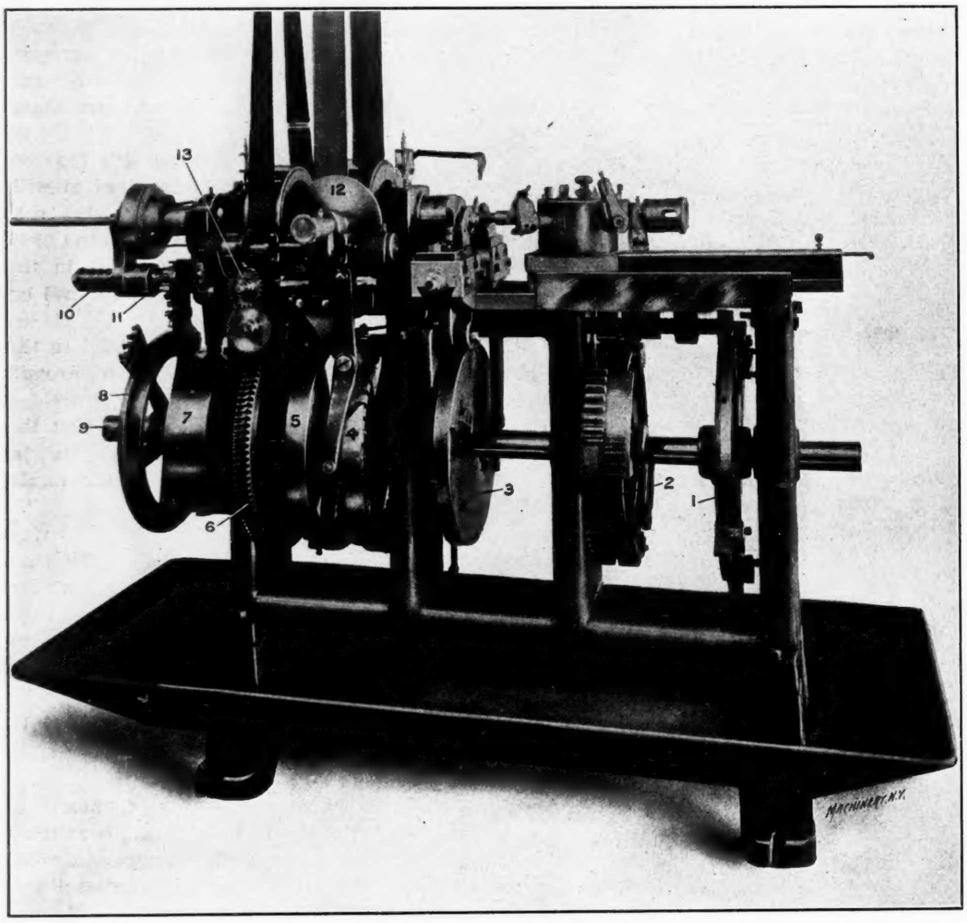
The staterooms of the steamships *Minnesota* and *Dakota*, now nearly completed at New London, Conn., for the Pacific trade, are to be heated with electric heaters, similar to the electric heaters used in trolley cars. These vessels are designed primarily for freight purposes, but provide unusually attractive accommodations for such passengers as are carried and the electrical equipment is said to be the most complete ever placed on shipboard.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

NEW AUTOMATIC SCREW MACHINE.

A new universal automatic screw machine, the invention of J. P. Lavigne, master mechanic of the Detroit Lubricator Co., Detroit, Mich., is shown in the accompanying illustration. The construction of the machine is such that any one can set it up for any piece of work, by means of the instructions furnished, as the adjustments are not at all complicated. It will produce any class of work without requiring any parts such as cam faces, which heretofore have frequently had to be designed for the work to be performed.



The Lavigne Automatic Screw Machine.

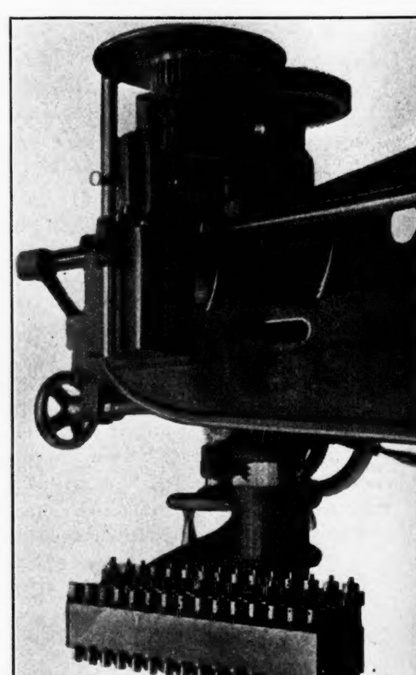
The machine is driven by two belts running on pulleys which are loose on the main spindle. One of these belts is simply for the reversal of the spindle, while the other one drives it in a forward direction while the tools are cutting and also furnishes power for rotating the cam shaft marked 9 in the engraving. Power is transmitted to the cam shaft through the friction disk 12 which runs in contact with a leather surface on the forward belt pulley. This friction disk is carried by a sleeve on a short horizontal shaft which it drives by means of a worm and worm wheel, and thence transmits power to the cam shaft 9 by the train of gears 13, which finally give motion to the wormwheel 6. Inasmuch as the timing of the different parts of the machine is governed entirely by the speed of this cam shaft, it is desirable to have means for adapting this speed to the different requirements. This is accomplished by two speed devices. One of these consists of a set of differential back gears attached to the shaft which drives the wormwheel 6, and the other, of arrangements for moving the friction disk 12 longitudinally on its shaft, which gives a smaller but gradual variation in the driving speed. The friction disk is moved by a lever which derives its motion from cams attached to wheel 4, and which can be so adjusted by means of slots in the face of the wheel as to give any desired motion to the disk at any time during the revolution of the shaft.

The differential back gears are operated by a clutch. This clutch is thrown in or out by cams clamped to one side of the wheel 5. The clamps are also attached to the other side of this wheel for operating the clutch connecting one or the other of the two main belt pulleys with the lathe spindle. The type of cam used on wheel 5 is used throughout the machine wherever possible, since it is easily attached and can easily be adjusted to any position. The chuck for holding the stock is operated by cams on the wheel 7, and the device for feeding the bar of stock through the spindle is operated by toothed segments on the wheel 8. At 10 is a coarse pitch screw, the rotation of which moves the stock-feeding device. On the right-hand end of this screw is pinion 11 and below it is an intermediate pinion. These are so located that one of the segments clamped to wheel 8 will mesh directly with the pinion attached to screw 10, and the other segment will mesh with the intermediate pinion turning the screw in the opposite direction and thus moving the feed device back to position where it is ready for again feeding the stock forward.

Now going to the other end of the cam shaft we find wheel 1 for moving the turret-locking bolt in or out of position by means of cams clamped to the periphery of the wheel. At 2 is a wheel carrying two sets of segments designed to mesh with pinions which rotate a screw visible under the turret, causing a nut on the screw to travel back and forth and thus operate the turret-turning mechanism. The distance that the turret is turned at any time is governed by the length of the segment on wheel 2. At 3 are two disks clamped together, which carry cams for operating the tool slides. These disks can be adjusted relatively to one another by twisting slightly upon the shaft, so as to bring the two tools into position where they will operate on the stock simultaneously.

MULTIPLE DRILLING ATTACHMENT.

The Mueller Machine Tool Co., Cincinnati, O., have brought out a new drilling device



Multiple Drilling Attachment for Radial Drills.

which we show herewith, to be applied to a radial drill. This device permits 60 holes to be drilled at the same time by operating the usual feeding levers.

The main casting, or head, is clamped to the machine sleeve, which is raised and lowered by means of its rack and pinion. The radial spindle runs loose in this head, and, by means of teeth cut on the spindle next to the sleeve, drives the sixth gear in the first row of 15 spindles, which mesh together. These spindles have 1½ inch centers, and each of them drives three others in rows at right angles to the first row. Their centers are 1⅛ inches in order to allow the teeth of their gears to pass each other as they run in opposite directions. Thus 30 right- and 30 left-hand drills are used to do the drilling. With the aid of a graduated dial on the cross screw, and a table having its adjustment at right angles to the radial arm, thousands of holes can be drilled with accuracy, down to ¼ inch center distances.

SHAPER INDEX CENTERS.

The three photographs herewith, illustrating index centers for shapers, tell their own story and require but little description. They are manufactured by the Stockbridge Machine Co.

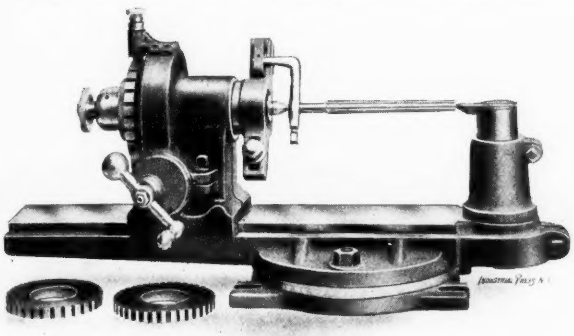


Fig. 1. Holding a Taper Reamer.

Worcester, Mass., the manufacturers of the Stockbridge shaper, and possess several points of novelty and usefulness that are original with this design.

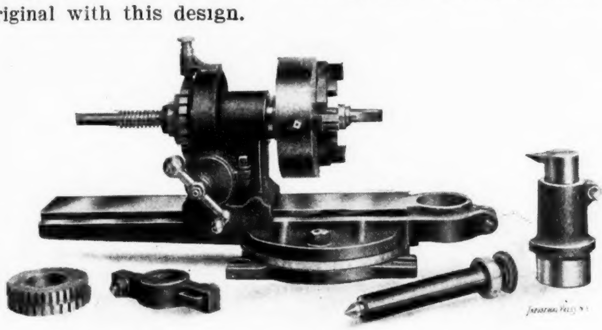


Fig. 2. Holding a Rod which Passes through the Spindle.

The illustration, Fig. 1, shows a taper reamer in position between the centers, and it will be noted that the tail center is raised sufficiently to bring the upper edge of the reamer parallel with the plane in which the shaper tool travels. Fig.

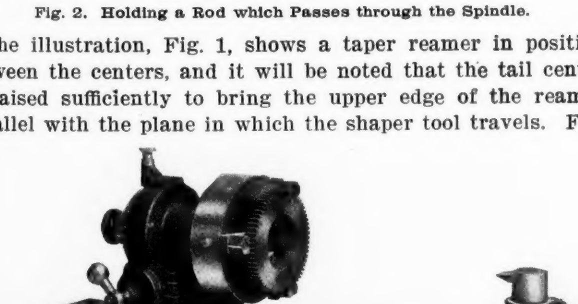


Fig 3.

2 shows the tailstock removed and the chuck attached in place of the dog holder. The spindle is also removed and a rod run through and held in the chuck, for squaring off the end. Fig. 3 shows a gear held in the chuck for the purpose of having the ratchet teeth cut.

The index centers swing 10 inches and take between centers 14½ inches. The hole in the spindle is 1 3-16 inches in diameter. It will be seen that the centers are designed to be used with a graduated base, such as is supplied with the Stockbridge shaper, but they can, of course, be used without this base by simply bolting directly to the shaper table.

NEW BENCH-STRAIGHTENING PRESS.

A bench-straightening press has been brought out by the Springfield Machine Tool Co., Springfield, O., which is of larger size than this company have heretofore made. The screw used in straightening the work is provided both with a hand wheel and a hand lever, the former being used for small work and the latter where considerable power is necessary. The hand wheel also permits adjusting the screw from large to small work, and *vice versa*, with rapidity. The centering heads are fitted upon a cold-rolled shaft 1½ inches in diameter, and have a capacity of 6½ inches diameter, with 40 inches between centers. Any length of shaft, however, may be straightened with this press, if occasion requires.

NEW UNIVERSAL JOINT.

The Boston Gear Works, Boston, Mass., have recently applied for a patent on an improved solid-ball universal joint coupling which they are now offering as a joint of unusually good design from the fact that it is strong and has no projecting parts. It is perfectly safe for the operator of the machine to stand close to one of these joints when running, as there is no possibility of his clothing catching.

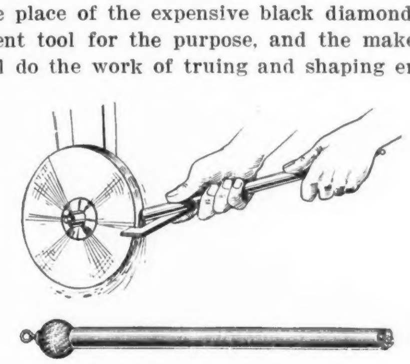
The bearing surface of the rubbing parts is also unusually large, so that it should be a durable joint. The only space inside the joint which is open is used for holding a lubricant,

A Ball Universal Joint.

which thoroughly lubricates the inside bearings. The opening of the oil well is closed by a screw. It is to be noted that this joint has a spherical bearing of large area directly on the ball, which latter is hardened and ground to exact dimensions. The joints are made with hub diameters of ½ inch to 4 inches and are manufactured in two styles: One for extra heavy duty and for angles up to 15 degrees measured from a straight line; the other style is not so strong but works up to angles of 30 degrees.

THE "SEMI-DIMOND" TOOL.

An emery wheel dresser manufactured by the International Specialty Co., 35 Holden Avenue, Detroit, Mich., is designed to take the place of the expensive black diamond. This is a most efficient tool for the purpose, and the makers write us that it will do the work of truing and shaping emery wheels



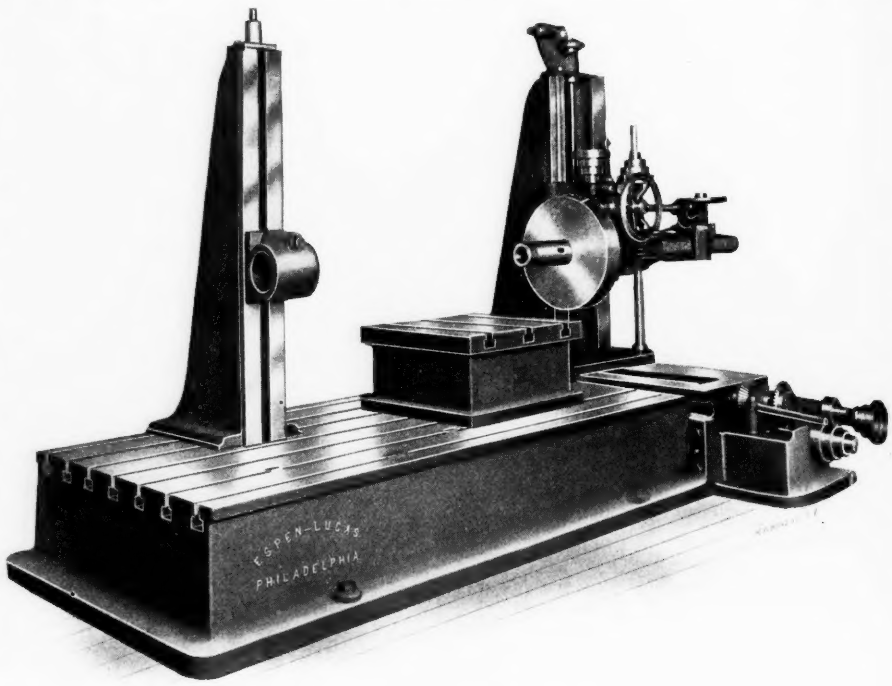
A New Emery Wheel Dresser.

in as satisfactory a manner as the diamond dresser. The "Semi-Dimond" dresser is a steel tube filled with the hardest abrasive that can be obtained, which presents new cutting edges the entire length of the tube and as long as it lasts, which is from three to five years, with ordinary use. The

dresser is not recommended for water grinders or very hard wheels, although it can be used on such if necessary. Its efficiency is best demonstrated on grades up to medium hard.

ESPEN-LUCAS HORIZONTAL FLOOR BORING, MILLING AND DRILLING MACHINE.

This new horizontal floor boring, milling and drilling machine has been designed by the Espen-Lucas Machine Works, of Philadelphia. This tool, while it conforms in its principal features to the more expensive and larger machines, is able to do the boring and a large amount of the milling heretofore necessarily done on the long milling machine. It covers an extra wide range and a great variety of work, being applicable to all kinds of boring, tapping, reaming and various kinds of milling, such as key-seating long, heavy shafting, etc. It can be used for face milling with a rotary cutter head like a rotary planer, and will do end milling and can be used for cotter drilling and cutting key-seats with an end mill. Large castings can be placed on the platen and work finished without removing the casting.



Horizontal Boring and Milling Machine.

The spindle, which is made of hammered crucible steel, is four inches in diameter and feeds through a gun metal sleeve. The boring bar has twenty inches of feed and has a No. 6 Morse taper hole in the end, also pin hole for retaining the bars and milling tools in place. The head has vertical adjustment of thirty inches and can be securely clamped in any position for milling. The column carrying the spindle head has automatic feed and quick return in both directions, giving forty-two inches of horizontal movement to the spindle head for milling. The spindle has feed in either direction for boring and counterboring both ends of cylinders. The machine, among other things, takes the place of the old style boring machine, where the work had to be adjusted to the spindle instead of the spindle being adjusted to the work, and, in this case, also relieves the milling machine of some of the large work, which would require a larger tool. The spindle is geared powerfully for heavy work and with ample power for drilling. It has a five-step cone which gives it eighty changes of feed and twenty changes of speed. The gearing is made of steel, cut from the solid and the bearings are all lined with bronze. The machine can be built with plain or compound table, or with both. The platen is forty-two inches by eighty-four inches, well ribbed to carry large and heavy work, the tail support being built with or without horizontal adjustment. Accurately adjusting screws and micrometer adjusting dials are also attached, if required. The countershaft is so arranged that spindle can be run in either direction. Length and width of table, also length of movements in all directions can be increased to suit requirements.

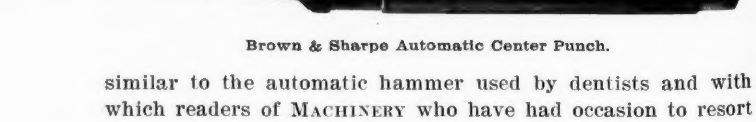
Celluloid Protractor Triangle.

A NEW PROTRACTOR TRIANGLE.

The accompanying illustration shows a draftsman's triangle, with a protractor combined, which is apparently an unusually useful tool, especially for rapid detailing. The tool is a 45-degree triangle, made in two sizes, 6 and 9 inches. It is of celluloid and the protractor arm is sprung into position, fitting snugly in V-grooves in the opening cut out of the triangle for the purpose. Just enough spring is given to the arm to maintain sufficient friction, so that it will stay in any position and yet can be moved readily. This arm has a vernier reading to 10 minutes, so that it can be set with sufficient accuracy for most requirements. When set at the 30-degree divisions the triangle becomes a convenient 30—60-degree triangle. One of the advantages of the construction is that lines which make a slight angle with the vertical and horizontal lines of the drawing, such as screw threads, for example, can be conveniently drawn by the use of a T-square and one of these triangles. It is made by the Triangle Protractor Co., Worcester, Mass.

BROWN & SHARPE AUTOMATIC CENTER PUNCH.

An automatic center punch has been brought out by the Brown & Sharpe Mfg. Co., Providence, R. I., which is entirely new in its design, combining features that make it much more convenient and accurate for laying out work to be machined or drilled than the ordinary center punch and hammer. The tool is self-contained, the striking mechanism being enclosed in the knurled handle, which is of such size and form as to be conveniently held in the hand. In operation the tool is



Brown & Sharpe Automatic Center Punch.

similar to the automatic hammer used by dentists and with which readers of MACHINERY who have had occasion to resort to the dentist chair are probably familiar.

In operation the point of the punch is placed at the point where the prick punch mark is desired, the handle is pushed down, which compresses the spring, and at the proper point the spring is released and causes the striking mechanism to deliver the blow. The tool is about 5¼ inches long by ⅝

inch in diameter. In designing it every care has been taken to combine lightness and simplicity with durability. The various parts are proportioned to withstand the most severe usage to which a tool of this character should be subjected.

When following a line or establishing a point by the intersection of lines, one hand can be free to guide the point or hold the magnifying glass and, after the point is located, it is not apt to slip and lose the setting, as just a downward pressure of the handle releases the striking block and makes the impression.

Another advantage appreciated by mechanics is that the punch marks are all of uniform depth and, therefore, more easily and accurately followed than when of varying depths.

AUBURN TOOL GRINDER.

A new tool grinder, shown herewith, is manufactured by E. F. Allen & Co., successors to George J. Ridley, Auburn, N. Y., manufacturers of the Auburn tool grinders. In this machine the water tank is located inside of base and below the touch of the grinding wheel. A disk located in a separate apartment revolves with sufficient speed to throw water up and onto the wheel. Water is admitted to the disk chamber by means of a special valve which is regulated by a hand-wheel in front of the machine. The rest is solid and substantial and

Auburn Tool Grinder.

is high above any obstructions so that the tool may be held in any desired position. The wheel is covered with a hood provided with an adjustable water guard. It will be seen from this description that the machine possesses several advantages in being free from levers, treadles, pump, pipes or other devices liable to get out of order or to be adjusted or operated each time the machine is used. It is automatic in action. When the machine is at rest the grinding wheel cannot be left soaking in the water, which is a very desirable feature.

THE "NATIONAL" NUT TAPPER.

The accompanying illustration shows a nut tapper recently placed on the market by the National Machinery Co., Tiffin, O. This machine is compact, simple and easily operated, and is intended for tapping small nuts in large quantities. Special attention has been given to the convenience of the operator, so that he may take full advantage of the high tapping speeds to which it is designed to run.

Each tap spindle is equipped with both a foot treadle and a hand lever, the latter to be used in starting the tap, should the operator allow it to become dull. Tap sockets are so designed that taps can be removed or inserted while the machine is running at full speed, but any spindle may be stopped independently of the others merely by lifting its hand lever to the highest point. Nuts with either right or left-hand threads can be tapped with equal facility.

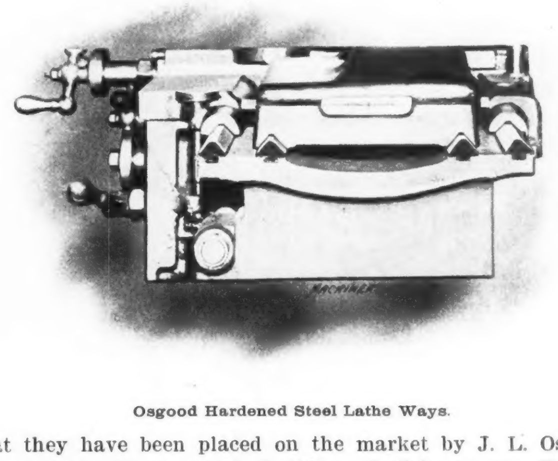
All gears are cut from solid stock, and are inclosed in a housing which protects the gears from dirt and the attendant from being caught in the gears. The rotary pump, shown near the bottom of the machine forces oil in jets against each tap, lubricating it, cooling it, and washing away the chips. The oil and chips drain into two iron drawers with screen bottoms. The screen retains the chips, but the oil filters through and returns to the pump.

National Machinery Company's Nut Tapper.

All joints are machined, making each part rigid and true. All bearings are scraped, and adjustments for taking up wear are provided at all necessary points. All parts are machined to standard size, and repairs are interchangeable. The regular equipment includes six taps and tap sockets of any size within the capacity of the machine.

OSGOOD LATHE WAYS.

Some two years ago we called attention to a patent which had been issued upon steel lathe and planer ways which were to be inserted in the bed of the lathe, or table of the planer, in place of the usual cast-iron ways which are part of the casting itself. The use of these ways has now been developed so



Osgood Hardened Steel Lathe Ways.

that they have been placed on the market by J. L. Osgood, 121-131 Erie County Bank Building, Buffalo, N. Y. The application of these ways to a lathe is shown in the accompanying illustration. They are of cold-drawn, very high-carbon

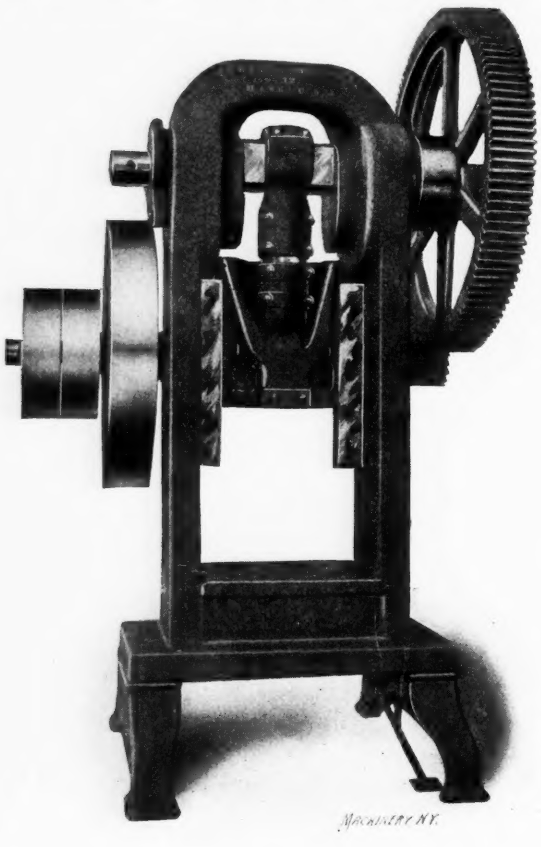
steel, and are smooth, true and bright, can be furnished in any lengths, with dimensions within limits of 0.002 inch.

In the circular supplying information upon these guides it states that they will not dent, grind or cut, and have a hardened surface which reduces friction and prevents wear. They will stand heavy strain and high-speed tool steel without showing signs of wear.

These guides are either sold separately or lathes will be supplied fitted with them, as desired. They are also well adapted for the repair of old lathes having guides which are defective. They are made in 9 sizes, ranging from 13-16 inch wide for 10 and 11-inch lathes up to 2½ inches wide for 48-inch lathes. The sides of the guides make angles of 45 degrees with the horizontal.

HEAVY STAMPING AND FORMING PRESS.

The illustration herewith shows a new press that has been brought out by the Perkins Machine Co., Warren, Mass., with improvements especially adapting it for heavy stamping and forming. The press has an 8-inch stroke of plunger, the plunger ways being set off center, so that the center of the plunger overhangs a distance of from 4 to 5 inches. By this



New Perkins Press.

construction the press can be so adjusted that the ram will travel up above the lower ends of the guides and the guides will not interfere with the punch, which has heavy strippers and spring bolts. The adjustment of the plunger can be effected quickly by a slight turn of the screw, which latter has a right- and left-hand thread.

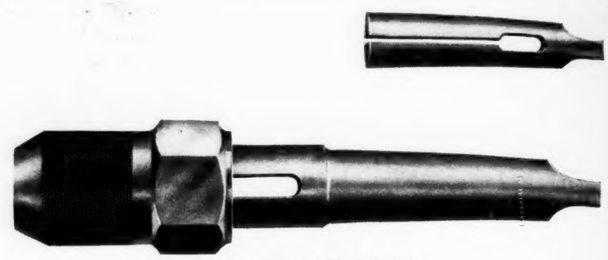
DRILL CHUCK FOR TAPER SHANK DRILLS.

The National Twist Drill and Tool Co., 21st and Standish Streets, Detroit, Mich., have placed a drill chuck on the market designed especially for holding taper shank drills. It will hold any such drills securely, even after the tang has been broken off.

The body of the chuck is bored out to form a taper socket, and is split so that it can be compressed slightly by a taper sleeve, which screws on the outside of the chuck. For smaller size drills split taper collets are used and for drills having the Graham grooved shank a special collet is provided, not shown in the engraving.

It will be evident that the construction is such as to enable the chuck to bear firmly against the whole taper surface of the drill shank, making practically one solid body of the drill, the collet and the chuck.

The chuck is made in several sizes, to accommodate a wide



National Twist Drill Holder.

range of drill sizes. The parts of the chuck are interchangeable, and new collets can be ordered at any time. The chuck is made of tool steel, properly hardened.

* * *

FRESH FROM THE PRESS.

BOILER CONSTRUCTION, by Frank B. Kleinhans. 421 pages, 5½x7⅞ inches, illustrated with 334 line cuts and half-tones, and five large plates. Published by the Derry-Collard Co., 256 Broadway, New York. Price, $3.00.

This work is essentially one for the working boilermaker, being "a practical explanation of the best modern methods of boiler construction from the laying out of sheets to the completed boiler." It is confined to the problems of construction involved in the locomotive type, the inference being that any boilermaker who is competent to handle the difficult construction required in modern American locomotive boilers, should be amply competent to cope with the simpler construction of stationary and marine types. The work logically begins, of course, with the laying out of the sheets, taking up in order gusset sheet development, development of irregular shaped sheet, laying out of dome sheet, dome base, first course, laying out first course sheet, front tube sheet, smokebox sheet, etc. Following the section or chapter on laying out which covers nearly 60 pages, are sections on flanging, forging, punching, shearing, bending, machining parts, under which general head comes drilling, turning and boring, tapping and reaming, planing, milling, etc. The important subject of riveting is comprehensively treated, following which are boiler details including under this head stay bolts, crown stays, crown bar bolts, crown bars, etc. A specially valuable feature of the book is the numerous half-tone illustrations of modern boiler shop tools, but the practical boilermaker will doubtless more appreciate the fine line cuts from actual working drawings with which the different sections are copiously illustrated. The work is what we believe to be one of the most practical and comprehensive mechanical books ever published. No expense has been spared to make the illustrations the best obtainable. Mr. Kleinhans, the author of the work, is well known to our readers as a clear and logical writer on problems in theoretical and constructive mechanics. He has had a wide practical experience, including service with the Baldwin Locomotive Works where the larger part of the data for this work was collected. The book is handsomely bound in drab cloth with a symbol on the front cover representing the tubesheet of a boiler. For some reason the imprint of the title was omitted from the back which we believe was a mistake when the convenience of being able to select a book from a row on a library shelf by inspecting the titles on the back, is considered. This, however, in no way detracts from the general excellence of the work—would that there were more like it.

MANUFACTURERS' NOTES.

MR. GEORGE K. WILLAND, formerly secretary of the Washburn shops, Worcester Polytechnic Institute, recently tendered his resignation, to take effect August 1. Mr. Willand has been connected with the Institute for the past 10 years, but is now to enter in the manufacturing business in Worcester.

THE STANDARD ENGINEERING CO., Elwood City, Pa., makers of bolt threaders and pipe threading and cutting machines have appointed Mr. A. Schaefer their New York sales manager, with office at 150 Nassau Street.

THE CINCINNATI MACHINE TOOL CO., Cincinnati, O., have now completely moved their plant and are located in their new quarters at Spring Grove Avenue and Townsend Street, which plant is particularly designed for the building of upright drills. They state they will be glad to show interested parties through at any time.

THE FOOTE BROS. GEAR & MACHINE CO., at Chicago, Ill., have succeeded the firm of James & Foote, whose good will and plant they have recently purchased, excepting bills receivable and bills payable. They will continue the old business at their permanent location 24-30 So. Clinton St., Chicago, Ill.

THE INGERSOLL-SERGEANT DRILL CO., New York, have received an order from the O'Rourke Engineering & Construction Co., who have the contract for building the Pennsylvania tunnel under the Hudson, for two Central compressed air power plants to be located at New York City and at Weehawken, N. J. This order includes eight 36-inch stroke Corliss air compressors each of 3,890 cubic feet capacity.

HENRY R. WORTHINGTON CO. are distributing a small map showing the location of their old works in South Brooklyn, their offices in New York and their new works at Harrison, N. J. The new plant occupies a 34-acre tract, has 18 acres of floor space and will accommodate 6,000 workmen. It is said to be the largest industrial plant near New York, and embraces the latest improvements in engineering production.

THE PERKINS MACHINE CO., Warren, Mass., who recently moved from South Boston to a larger factory at their present location, Warren, report that owing to the large orders which they are receiving they are still running day and night to execute same. They have been obliged to add another crane to their equipment, the addition being a large Pawling & Harnishfeger three-motor electric traveling crane, of the latest model.

NEW TRADE LITERATURE.

Manufacturers and others sending catalogues for notice are requested to address them to the Editor of MACHINERY, so that they can be kept separate from catalogues sent us for other purposes.

THE ECK DYNAMO & MOTOR WORKS., Belleville, N. J. Bulletins No. 34 and 35 of the "Eck" small motors for direct current, with price list.